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CHEMICAL AND BIOLOGICAL ENGINEERING DEPARTMENT SEMINAR SERIES

Modeling of PEM fuel cell electrodes: Understanding the influence of component microstructure and property on electrochemical performance

Presented by: Kunal Karan, RMC Fuel Cell Research Centre and Queen's University
Department of Chemical Engineering

Time: Wednesday, April 8; 3:15 – 4:30 pm

Location: Perlstein Hall Auditorium

Abstract
Fuel cells have been promoted as the next generation technology for power production. Some have touted fuel cells as a single-platform, universal electricity generator and the energy conversion device for stationary and mobile applications. For automotive applications, polymer electrolyte membrane fuel cells (PEMFCs) are at forefront among the various FC technologies. For widespread commercialization, however, fuel cell stack cost must be reduced without compromising the performance. Both the cost and the performance of a PEM FC are strongly linked to the material properties and microstructural design of the electrodes.

The porous electrode of a PEM fuel cell is a fascinating world wherein several physical, chemical and electrochemical processes occurs simultaneously involving three distinct species – one or more neutral chemical species (hydrogen, oxygen, water), electrons, and ions. At the core of this microcosm of activities is the electrochemical reaction in the catalyst layer (CL) which results in either the generation or the consumption of electrons. The electrochemical reactions occur only at those sites where the three reacting species are able to arrive through respective transporting phases. Thus, there is strong coupling between the transport processes and the electrochemical reaction. The porous electrode represents a distributed system wherein the rate of reaction is distributed in three dimensions. The distribution of reaction is influenced by both the macroscopic and microscopic pathways available for transporting the three reacting species – electrons, ions and neutral chemical species. Expectedly, the material, micro-structure and design of the fuel cell sub-component influence the electrochemical performance.

The seminar will present mathematical model of PEMFC electrode that is based on consideration of the microstructure and material properties of PEMFC electrode components - catalyst layer and porous carbon backing. The influence of key structural and transport properties of these two components will be examined. The insight gained will be presented in the context of micro-engineering of catalyst layer for designing low-Platinum content electrodes.

Biography
Dr. Kunal Karan is an Associate Professor of Chemical Engineering at Queen's University and an Associate Director of the Queen's-RMC Fuel Cell Research Centre, Kingston, Canada. His research is primarily focused on the modeling and characterization of coupled reaction-transport processes occurring in fuel cell electrodes with a goal of micro-engineering the electrodes to maximize electrochemical performance. He has authored/co-authored 45 refereed articles and over 60 conference presentations. Dr. Karan recently received The Early Researcher's Award (2007) from the province of Ontario, Canada. At Queen's, Dr. Karan has received the prestigious Golden Apple Award for Excellence in Teaching, 3 times in last 6 years.