The Waterloo Institute for Nanotechnology

Seminar Series

Dr. Ned Djilali, FRSC, FCAE

Professor & Canada Research Chair, University of Victoria, Canada

Modelling and Simulation of Transport Phenomena in Fuel Cell Electrodes

Fuel cells are efficient electrochemical energy conversion devices that can provide zero emission power for applications ranging from portable electronics and road vehicles, to residential power generation. They have the advantages of high energy density, fast start-up, and scalability. A key component of a fuel cell is the electrode, which facilitates the electrochemical reaction and the transport of reactants, charge, and byproduct heat and water. Fuel cell electrodes consist of three tightly integrated layers having distinct characteristics: a nano-structured catalyst layer, a micro-porous layer, and a gas diffusion layer. The complex porous structure and morphology of the layers largely determine the effectiveness of the transport processes and in turn the overall performance, cost and durability of a fuel cell. In this talk we will discuss some of the challenges and progress toward modelling and understanding the multiphysics, multiscale transport in the various porous layers of PEM fuel cells through a combination of advanced microscopy, numerical reconstruction, and pore scale simulations. We will also present some recent progress in the modelling and simulation of nano-particle agglomeration, an important process during fabrication that impacts the structure and morphology of porous catalyst layers.

Ned Djilali is Professor of Mechanical Engineering at the University of Victoria, where he holds the Canada Research Chair in Advanced Energy Systems Design and Computational Modelling. His research focuses on transport phenomena (fluid flow, heat, mass and charge transport) and energy systems analysis. The applications of this research have ranged from aerodynamics and zero-emission vehicles, to electrochemical energy conversion and the water-energy nexus. Prior to joining UVic, he was staff specialist with the Advanced Aerodynamics Department at Bombardier Inc., where he worked on the design of the Regional Jet. At UVic he has established an internationally recognized laboratory in the areas of thermofluid science, fuel cell technology and energy systems where he has trained many graduates who have become leaders in academia and industry.
Djilali has served as Director of UVic's Institute for Integrated Energy Systems and of the Pacific Institute for Climate Solutions, and was engaged in several initiatives including the BC Hydrogen & Fuel Cell Industry Strategy and the Hydrogen Highway deployed as part of the 2010 Winter Olympics. He has advised and collaborated with numerous industry partners, organizations and government agencies, including Toyota, Mercedes-Benz, Ballard, the BC Climate Action Secretariat, and the Wind Energy Strategic Network on the development and adoption of zero emission energy technologies, and has held visiting professorships at various institutions in Asia, Europe and North-America. Djilali lectures widely on various aspects of fuel cell technology and sustainable energy systems, has published over 180 peer reviewed journal papers (h-index 56), holds 15 patents, and serves on the editorial boards of several international journals. He is a Thomson-Reuters Highly Cited Researcher, and a Fellow of both the Canadian Academy of Engineering and the Royal Society of Canada.

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