NANOHOUR

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Beckman Institute - Room 3269

Nanoengineering of New Generation Small Fuel Cells

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The ever increasing demand for powering portable applications has generated a worldwide effort for development of high energy density power sources. In addition to their use in everyday portable electronics, such power sources could free soldiers from the burden of heavy battery packs and enable powering new applications such as small surveillance robots that require 1000s W-hr/L energy. Although advancements in lithium-ion battery technology in recent years have provided access to more portable energy, this progress has not kept pace with the increasing demands for energy, leaving a so-called power gap that is expected to grow in coming years. Small fuel cells that have been under development for some time have the potential to bridge this power gap. The theoretical energy density of candidate fuels is 1-2 orders of magnitude higher than that of current lithium ion batteries. However, efforts to harvest this high energy density have been hampered by issues concerning the fabrication, performance, reliability, size, and cost of small fuel cells. At the heart of these issues are deficiencies of the fuel cells membrane electrode assemblies (MEAs). The macroscale fabrication techniques as well as our understanding of the nano and molecular scale physics limit the performance boundaries of the MEAs. The existing technologies rely on complicated subsystems to overcome the MEA deficiencies. The key to addressing the existing challenges is innovation, and some of the most promising solutions are occurring at the nanoscale. Nanoengineering allows the creation of new building blocks to produce materials with the desired properties. In this talk, the physics of nanoscale phenomena as it relates to deficiencies and limits of fuel cells will be discussed. The concept of a surface nano-engineered fixed-geometry proton exchange membrane (PEM) is introduced. A nanoengineered PEM with fixed-diameter nanopores caped with a molecularly thin conformal film created on the membrane surface via plasma-directed atomic layer deposition (PD-ALD) is shown to achieve 100X higher proton conductivity than that of Nafion at low humidity.

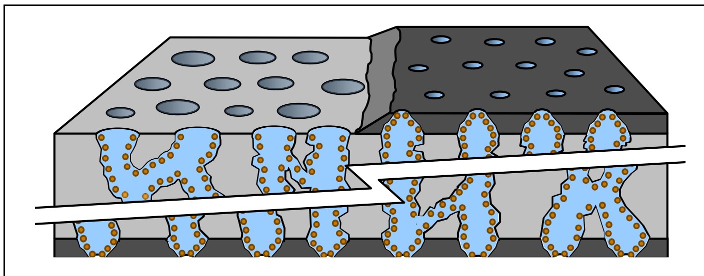

Figure 1. Schematic of a nanoengineered proton exchange membrane showing a porous membrane with sulfonate functionalized pore wall and 2 nm thick layers of porous silica on both sides of the membrane. Pores are approximately 25 microns long and have a diameter of ~5 nm. The lateral scaling is stretched for clarity.

Bio: Dr. Saeed Moghaddam joined the University of Illinois at Urbana-Champaign (UIUC) in 2007 as a Post Doctorate Research Associate where he has been working on miniaturization of fuel cell systems and functional nanostructured membranes for energy science applications and fluidic MEMS/NEMS. His most recent efforts focus on performance enhancement of proton exchange membranes (PEMs). Dr. Moghaddam's work on small fuel cells has been recently featured in New Scientist and several other news outlets as well as 2010 Guinness Worlds Records.

Coffee and cookies will be served

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