Oral Defense Announcement
University of Missouri – St. Louis Graduate School

An oral examination in defense of the dissertation for the degree
Doctor of Philosophy in Physics

Waruni Jayawardana

M.A. in Physics, August 2014, University of Missouri-St. Louis
B.Sc in Applied Sciences, August, 2011, University of Peradeniya

Nanoporous Carbon Scaffolds for Energy Storage Applications

Date: November 13, 2018
Time: 2:00 p.m. to 4:00 p.m.
Place: 101 Center for Nanoscience (CNS) Hall

Abstract
Nanoporous carbons have become increasingly popular in various fields of research due to their unique properties including tunable pore sizes, higher pore volumes and higher surface areas, as well as being able to produce controlled nanostructures. The work presented here uses nanoporous carbon scaffolds with as active hosts for (1) Li-ion battery electrodes and (2) confined metal hydrides for hydrogen storage applications. In (1) we investigate the Li diffusion characteristics in hard carbons that are important for electrochemical applications. We develop a novel method named Voltage-Relaxation Galvanostatic Intermittent Titration Technique (VR-GITT). Parameters derived from the fitting of electrochemical data provide both the diffusion constants as well as morphological information about the diffusion geometry. The VR-GITT method also allows determination of the diffusion constant in the two-phase region of many materials, where the standard GITT method fails. In (2) it is already known that confining hydrides in nanoporous carbons can alter the the kinetics of de/re-hydriding reactions. We investigate the effects of changing the surface electron density in these hard carbons by the addition of nitrogen. The various chemical environments for the surface nitrogens include pyridinic and pyrrolic. The pyridinic nitrogen contains a lone pair of electrons that should be available to form Lewis-acid/base complexes that interact with confined hydrides, and provide a favorable (wetting) surface energy for incorporation of alane (AlH₃), lithium borohydride (LiBH₄), and other hydrides into the carbons. Our results indicate that both B and Al interact with these pyridinic nitrogens upon introduction to the carbons. The infiltration of LiBH₄ is straightforward, while the infiltration of AlH₃ requires oxygen reduction techniques during the carbon scaffold synthesis.

Defense of Dissertation Committee
Eric H. Majzoub, Ph.D. - Chairperson
Alexey Yamilove, Ph.D.
Philip Fraundorf, Ph.D.
Stephen M. Holmes, Ph.D.
Julia E. Medvedeva, Ph.D.