

Addressing the scale and complexity of the global energy challenge.



NANOMATERIALS FOR GAS STORAGE AND SEPARATIONS VIA A TRAPPING MECHANISM

James and Catherine Patten Seminars

Angela D. Lueking, Department of Energy & Mineral Engineering
Department of Chemical Engineering, The Pennsylvania State University

Tuesday, November 1, 2011

11:00 a.m., ECCR 105 (Engineering Center)

Refreshments will be served shortly before the seminar

Summary: Increased efficiency in the utilization of our energy resources in a carbon-constrained world will require efficient and effective routes for energy conversion, separations, and carbon capture. We are currently exploring novel trapping mechanisms for gas storage and separations, using a collaborative combination of experiment and theory. In one study, we are looking at how carbon materials may be engineered to trap molecular hydrogen in tightly knit micropores, through catalyst addition (i.e. hydrogen spillover), penetration under extreme pressures, and polymerization of polyaromatic hydrocarbons in the presence of molecular H₂. In the former, we are utilizing high-pressure in situ characterization techniques to identify the mechanism by which reversible hydrogenation of the carbon substrate is possible. In the two latter cases, we believe hydrogen loading under extreme conditions may lead to diffusion-limited hydrogen evolution from the materials, after simultaneous hydrogenation and carbon restructuring. In a second study, we are exploring the kinetics of the novel 'gate-opening' (GO) phenomenon that has emerged for metal-Organic Frameworks (MOFs) materials. GO is typically characterized by an unusual S-shaped isotherm that is thought to be due to activation of a thermodynamic switch at a particular temperature and pressure that opens the structure, allowing for a significant increase in porosity. The GO phenomenon remains poorly understood and relatively unexplored in terms of classic and emerging gas separations. In our laboratory, we have demonstrated that the gas-surface interaction dictates the rate of diffusion into the material, and this can be harnessed for kinetic separations. The two studies taken as a whole describe the diffusion-limited evolution of gases, representing a shift from 'traditional' solid state adsorbents with thermodynamic limitations to a regime that is limited by chemical kinetics. In this talk, I will discuss the original 'inspiration' behind our work in trapping, our recent use of in situ spectroscopic techniques to identify active adsorption sites, the kinetics of gas trapping, and then propose a means by which to utilize these phenomenon in gas storage and separations.

Angela Lueking, Ph.D.

Angela Lueking is an Associate Professor at Pennsylvania State University's University Park campus, with joint appointments in the Energy & Mineral and Chemical Engineering Departments. Angela's expertise is in adsorption measurements, advanced characterization, and development of new materials for energy and environmental applications. Her research currently focuses on design of materials for hydrogen storage through creating synergistic material composites based on incorporating catalytic materials into both carbon materials and metal-organic frameworks. She is also exploring novel hydrogen storage mechanisms in an attempt to overcome the thermodynamic stale-mates of most hydrogen storage materials, by shifting the focus to materials that trap hydrogen in tightly knit pores via a kinetic trapping mechanism. This research comprises two active projects supported by the Department of Energy, including the Energy Efficiency and Renewable Energy Program and the office of Basic Energy Science, for which Angela is Principal Investigator. Angela obtained her PhD in chemical engineering and her MS in Environmental Engineering at the University of Michigan.

Campus Map for Engineering: <http://www.colorado.edu/campusmap/map.html?bldg=EC&x=14&y=8>

Recommended Parking: Euclid Avenue AutoPark