SEMTE seminar

Enabling advanced biofuel production through materials-inspired energy efficient separations

School for Engineering of Matter, Transport and Energy

Dr. Ryan P. Lively

Postdoctoral Research Associate

Algenol Biofuels

abstract

As corn-based biofuels reach their practical limits, advanced algae-based biofuels are poised to supply the rapidly increasing demand for renewable fuels. Large energy costs in biorefineries using traditional separation techniques for dilute feedstocks are currently a hurdle, but also a major opportunity for innovation. Advanced materials and their manufacturing into low-cost, energy-efficient separation devices to meet this challenge will be the focus of the talk. First, post-combustion CO2 capture will be discussed as an economical carbon source for the algae. A highly scalable materials production technique—fiber spinning—is used to create high-flux polyimide hollow fiber membranes as well as multi-layer hollow fiber sorbents that function as integrated adsorbing heat exchanging devices. Flexible zeolitic imidazolate frameworks (ZIFs) are identified as promising candidates for advanced filler materials in polymer-inorganic hybrids. The versatility of the fiber sorbent platform is illustrated. Materials synthesis, bench-scale module testing and technoeconomic analysis of these fiber-based systems will be presented. Besides the CO2 capture challenge, purification of dilute ethanol feeds must be addressed. In this regard, a highly hydrophobic zeolite is a uniquely attractive candidate for dilute ethanol recovery. Fundamental transport and thermodynamic characterizations of a suitable zeolite for this application are presented. Exceptionally high ethanol/water selectivities are obtained for the neat zeolite. Zeolite morphology control is demonstrated, as is the inclusion of high aspect ratio forms of the zeolite into hybrid materials. Routes forward for both separations are discussed.

biosketch

Dr. Lively's research seeks to revolutionize fluid separation processes critical to the global energy infrastructure via application of chemistry-inspired materials design. During his Ph.D. studies at Georgia Tech, he introduced a rapid temperature swing adsorption (RTSA) approach for post-combustion CO2 capture. This concept was successfully demonstrated by adapting knowledge developed in membrane science to design unique nanoscale composite adsorbent/heat exchangers. Through collaboration with faculty at Georgia Tech, Dr. Lively successfully guided this RTSA approach towards a new three million dollar research program at Georgia Tech funded by the Department of Energy, General Electric, Algenol Biofuels, and Southern Company.

Currently a post-doctoral fellow working for Algenol Biofuels, Dr. Lively is expanding his expertise in gas and liquid separations by designing new materials and processes for gas and liquid management in enclosed algal bioreactors. This position involves first-hand interaction with realistic separation challenges and requires workable solutions rooted in materials science. With an emphasis on materials research and a "top-down," process-guided materials development strategy, Dr. Lively has created membranes and sorbents that are tailored specifically for the challenges in the biofuels industry. An array of readily tunable microporous materials, functional polymers, tunable copolymers, and a stable of commercially available polymers are the tools used in his work. Dr. Lively has created composite materials (e.g., mixed matrix membranes, hollow fiber sorbents, micro-capillary heat exchangers, etc.) that can be integrated into demanding industrial systems.

February 7, 2013 at 10:00am in ERC 490