SYSTEMATIC DESIGN OF POLYMER-IONIC COMPOSITES FOR CARBON CAPTURE

Rebecca Martin

Advisor: Louis Madsen

Department of Chemistry and Macromolecules Innovation Institute

Virginia Tech, Blacksburg, VA

Abstract

Gas separation is critical for long-duration, crewed-spacecraft mission atmospheres where the accumulation of carbon dioxide (CO_2) from human respiration can result initially in headaches and ultimately in death. The creation of novel, stable, regenerable and selective CO_2-capture sorbents through fabrication of solid-state materials based on polymers and ionic liquids (IL) will provide an energy-efficient, high capacity, robust alternative to, for example, the existing zeolite systems used on the ISS. The incorporation of spin relaxation agents into these new materials enables the use of unlabeled CO_2 in ^{13}C NMR and NMR diffusometry methods to quantify sorption and transport within a practical testing timeframe. The successful generation of highly CO_2-sorbing polymer-ionic composite materials has achieved a primary objective and is an exciting step towards a new sorbent material for gas separations hitherto unexplored using previous solid-state IL-based systems. These new composite materials can mitigate slow gas transport without sacrificing IL filling factor or CO_2-sorption capacity as seen in conventional IL-based materials. Simultaneously, we can finely tune and optimize these composites based on an improved fundamental understanding of the processing, material component concentrations, and IL molecular structures.