Abstract

Greenhouse gas emissions have grown over the past decades. As the effects of climate change impact more people, carbon capture has been suggested as a tool for climate change mitigation. Carbon capture in ambient air, known as direct air capture, can be used to capture CO_2 from non-localized sources. Although there are many materials capable of carbon capture, few have demonstrated commercial viability on a large scale. Currently, liquid alkanolamines are used in absorption to scrub post-combustion flue gases, but the process requires enormous quantities of energy to regenerate. Instead, an alternative involves impregnating amines onto a solid surface for adsorption. Amine-based adsorbents have been studied for their higher surface area, lower cost, and ease of regeneration.

In this work, we investigate electrospun fibers of polyethylenimine cospun with polystyrene for their carbon dioxide adsorption behavior. Fibers were characterized by nuclear magnetic resonance spectroscopy (NMR) and light microscopy. CO_2 adsorption and desorption experiments were performed with thermogravimetric analysis (TGA) at temperatures between 30°C and 80°C. Samples with 20wt% PEI to 80wt% PS in a 13wt% polymers to 87wt% solvent were found to have the highest equilibrium adsorption capacity at 0.92 mmol CO_2/gram adsorbent.

TGA was used to determine the ideal operating conditions for carbon dioxide adsorption. Although equilibrium adsorption capacity should decrease and adsorption rate should increase with increasing temperatures, 60°C was the optimal temperature for both adsorption capacity and adsorption rate. To investigate this further, fibers were exposed to a higher "treatment" temperature before lowering the temperature. A 60°C heat pre-treatment led to improved adsorption capacities compared to samples not treated, even when the adsorption capacity was run

at lower temperatures. It is believed that a structural change in the fibers at higher temperatures caused structural changes in the adsorption process leading to the increased capacity.