Shapeable Microporous Polymer Supercontactor/Sorbent for CO_2 Capture from Air

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Abstract and Introduction

Polymers with intrinsic microporosity (PIMs) are well-studied porous organic polymers (POPs), which can be synthesized inexpensively and under mild reaction conditions. In contrast to most POPs, PIMs can be processed into thin films and fibers. Consequently, the majority of the studies on PIMs have focused on gas separation membrane applications, which feature exceptionally high permeability and moderate selectivity for several different light gas pairs. Although PIM-based membranes have been among the best performing gas separation materials, few studies have examined PIMs as solid sorbents for CO_2 capture or other gas separations. While PIMs possess the high surface area and permanent microporosity desired for a sorbent, they also suffer from low CO_2 adsorption capacity (<10 cc/g, 0.15 bar and 298 K) due to relatively large (>1nm) non-polar micropores, as well as some mesopores. This work synthesized the most studied PIM, PIM-1, and post-synthetically functionalized PIM-1 with carboxylic acid (-COOH) and amide (CONH2) functional groups to create a sorbent media with a moderate surface area and strong bonding sites for primary amines.

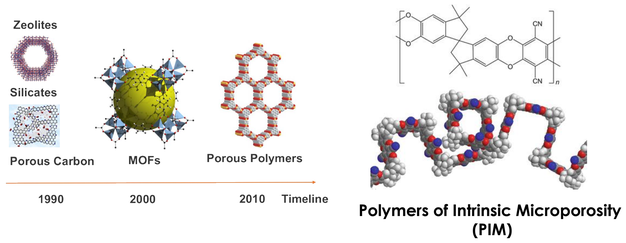

Figure 1. Porous sorbents developed overs the years. Chemical structure of PIM-1 discovered by Budd and Mckeown.[1]

Research Objective

Provide an optimized microporous polymeric sorbent contactor technology that can be fabricated in various geometries to form a module with minimum pressure drop for low-concentration CO_2 capture.

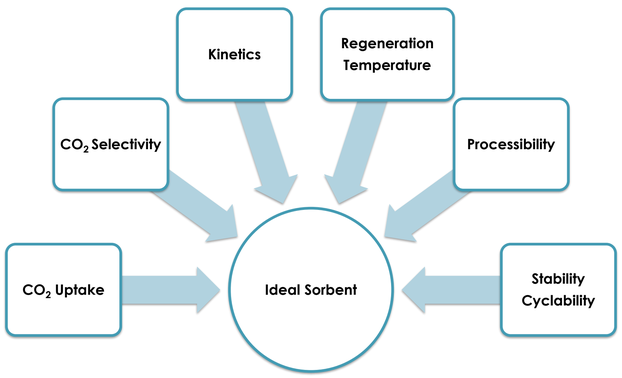

Figure 2. Desired sorbent properties for sorbents in CO_2 capture.

Results and Discussion

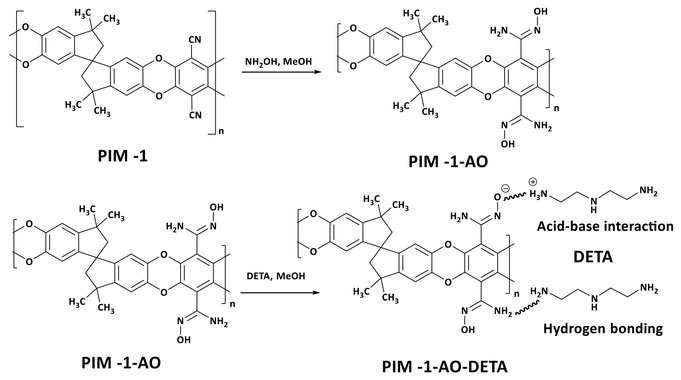

Figure 3. Structural figures of PIM-1, PIM-1 Amidoxime, and PIM-1-AO-DETA.

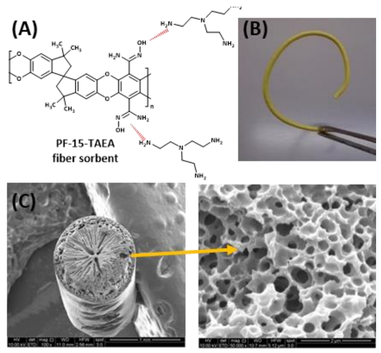

Figure 4. (A) Chemical Structure, (B) top view, and (C) cross-section SEM images of PF-15-TAEA sorbent.

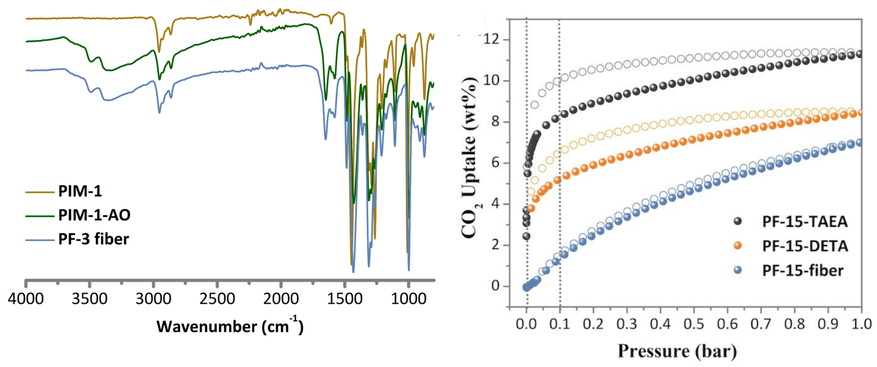

Figure 5. (A) FTIR of PIM-1, PIM-1-AO, and PIM-1-AO-TAEA (PF-3 –fiber); (B) CO_2 adsorption of PIM-1-AO fiber (PF-15-fiber), PIM-1-DETA (PF-15-DETA), and PIM-1-AO-TAEA (PF-15-TAEA).

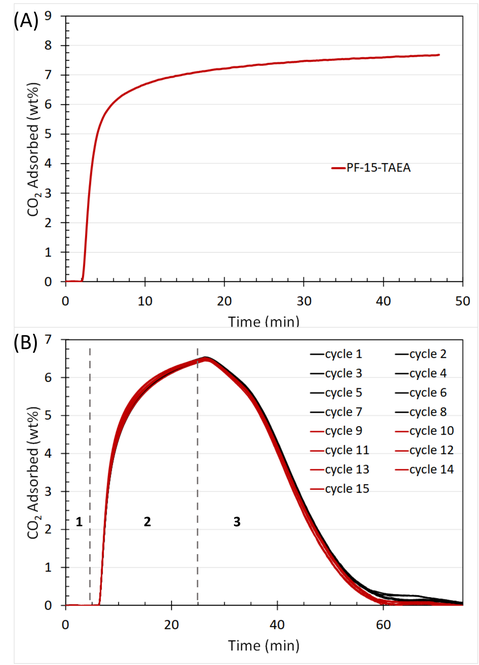

Figure 6. CO_2 uptake in PF-15-TAEA. (A) Measured in flowing gas at a total pressure of 100 mbar, 25 °C. The switch from pure N_2 to 10%CO_2/90%N_2 occurs at 2 min. (B) Adsorption/desorption cycles in flowing gas at a total pressure of 1 bar. Conditions: (1) pure N_2, 25 °C; (2) 10%CO_2/90%N_2; and (3) temperature ramp in pure N_2 at 3 °C/min to 70-75°C (black) or 75-80 °C (red).

References

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