Scientific Achievement

PIM-1, a solution-processable, permanently microporous polymer has been demonstrated as a viable support material for PEI, the benchmark aminopolymer used for CO₂ capture.

Significance and Impact

PIM-1 has the ability to be processed into novel geometries for CO₂ capture contactors (such as hollow fibers and others), thus allowing for major gains in energy efficiency of adsorption systems relative to traditional pellet-based systems due to improved heat mass management, lower pressure drops and more rapid mass transport.


Research Details

- PIM-1 powders and fibers were impregnated with PEI; physical properties as well as CO₂ capture performance were determined and compared to a porous silica/PEI composite (PEI/SBA-15).

- Hierarchical PIM-1 solid fibers displayed similar CO₂ capture trends to their powder counterparts, PEI/PIM-1 also possessed better adsorption kinetics and amine efficiencies than PEI/SBA-15.

- Rapid temperature swing adsorption experiments with PEI/PIM-1 fibers demonstrated good CO₂ capacity under both dry and humid conditions.

- Solid-state spin diffusion NMR experiments suggest that PEI is well-dispersed throughout the PIM-1 micropores.

PIM-1 can be used as a support for PEI for use in CO₂ capture and is solution-processable, allowing it to be formed into a wide range of topologies, all of which retain the permanent microporosity afforded by the molecular structure of the polymer.
Better dispersion of PEI in PIM-1 than in SBA-15 allows for higher amine efficiencies and faster adsorption kinetics.

<table>
<thead>
<tr>
<th></th>
<th>Q_{10%} (mmol/g)</th>
<th>N efficiency</th>
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<tbody>
<tr>
<td>PIM-1</td>
<td>1.2</td>
<td>0.24</td>
</tr>
<tr>
<td>SBA-15</td>
<td>1.6</td>
<td>0.18</td>
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PIM-1 as a Solution-Processable “Molecular Basket” for CO$_2$ Capture from Dilute Sources

Fibers behave similarly to powders but are more suitable for use in high flow rate / low pressure drop devices.
PIM-1 as a Solution-Processable “Molecular Basket” for CO₂ Capture from Dilute Sources

Simulated flue gas
14% CO₂, 14% He, 0-75% RH, balance N₂

To mass spectrometer

High gas flow rates allow for rapid cycling of PEI/PIM-1 sorbents under both dry and humid capture conditions