Metal-Organic Frameworks as New Materials for Carbon Dioxide Capture and Storage

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Removal of CO_2 from the flue exhaust of power plants, currently a major source of emissions, is commonly accomplished by chilling and pressurizing the exhaust or by passing the fumes through a fluidized bed of aqueous amine solution, both of which are costly and inefficient. Other methods based on chemisorption of CO_2 on oxide surfaces or adsorption within porous silicates, carbons, and membranes have been pursued as means for CO_2 uptake. However, in order for an effective adsorption medium to have long-term viability in CO_2 removal it should combine two features: (i) a periodic structure for which CO_2 uptake and release is fully reversible, and (ii) a flexibility with which chemical functionalization and molecular level fine-tuning can be achieved for optimized uptake capacities. MOFs represent a class of porous materials that offer these advantages for CO_2 storage: ordered structures, high thermal stability, adjustable chemical functionality, extra-high porosity, and the availability of hundreds of crystalline, well-characterized porous structures yet to be tested. Accordingly, we embarked on a program to assess the viability of MOFs in CO_2 storage. Nine compounds were selected in order to examine a range of structural and porous attributes. The list represents a cross-section of framework characteristics such as square channels (MOF-2), pores decorated with open metal sites (MOF-505 and $Cu_3(BTC)_2$), hexagonally packed cylindrical channels (MOF-74), interpenetration (IRMOF-11), amino- and alkyl-functionalized pores (IRMOFs-3 and -6), and the extra-high porosity frameworks IRMOF-1 and MOF-177. Comparison of the volumetric capacity of MOF-177 to current benchmark materials zeolite 13X and MAXSORB® reveal that at 35 bar and room-temperature, a container filled with MOF-177 can capture nine times the amount of CO_2 in a container without adsorbent, and about two times the amount when filled with benchmark materials. These results show that MOFs represent a new direction for preventing CO_2 in exhaust gases from reaching the atmosphere.

Further reading:

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3. Eddaoudi, M., Kim, J., Rosi, N., Vodak, D., Wachter, J., O'Keeffe, M. & Yaghi, O.M. *Science* **295**, 469-472 (2002)