Novel Nanomaterials for Gas Storage and Separations

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Our primary focus has been on material development for gas storage and separation, processes which are specifically relevant to utilization, purification, and storage of the natural gas within the Marcellus Shale. Robust solid state adsorbents will increase the density of methane in storage tanks, while new sorbent materials may enable methane purification at moderate temperatures and pressures. The former has the potential to significantly increase storage capacity, while the latter has the potential for significant energy reductions compared to cryogenic purification methods. In our laboratory, we have developed a method to create carbon-based cage materials that trap gases inside newly formed molecular-sized pores. A reactive mechanochemical process is used to activate the materials at temperatures and pressures that are significantly reduced relative to other carbon activation processes. We have relied heavily on advanced *in situ* characterization techniques to characterize the nature of the gas-solid interaction in these materials, as well as *in situ* studies to understand the mechanism behind the carbon transformations. We have recently published several fundamental studies revisiting the mechanism behind the 'gate-opening' (GO) phenomenon that has emerged for Metal-Organic Frameworks (MOFs) materials, and demonstrated this phenomenon may be attributed to mass-transfer limitations, and thus, can potentially be harnessed for kinetic separations of gases. We are currently looking to introduce metal particles into the GO-MOFs, and anticipate these new materials will have tunable structural properties making them advantageous for catalysis and ion exchange.