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Nanoporous materials for hydrogen and natural gas storage: in-situ neutron scattering observation of adsorbtion-induced structural changes[1]

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Hydrogen and natural gas offer cleaner alternatives to gasoline to power automobiles with a much faster fill-up time compared to battery-powered systems. However, efforts to roll out these systems are hindered by the difficulty of storing gases at the required densities. Hydrogen, the ultimate fuel in terms of emissions (only water), is especially difficult; inventing ways to store a gas with a critical temperature of 239.95 C (33.20 K) is a challenge of fundamental physics and chemistry. One promising system comprises the use of nanoporous materials to store the gas by physisorption. In this talk we will show investigations to the nature of these types of materials at the sub-nm scale, in particular whether these solids have structural changes during adsorption. Using in situ neutron scattering at the University of Missouri Research Reactor, we have observed an increase of the interlayer spacing in graphene oxide frameworks (GOF) for hydrogen, methane, and xenon at 0-150 bar and supercritical temperatures. We further observe an approximate law of corresponding states in this expansion and compare the experimental observations to molecular dynamics simulations of the system, which suggest possible structures for the GOFs. These observations may provide insight into the development of new materials optimized for gas storage or other applications.

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