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Nanoscale Hydrides in Porous Carbon Scaffolds

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Light element and complex anion hydrides (such as LiH, MgH₂, NaAlH₄, and LiBH₄) are being studied intensely as reversible hydrogen storage materials for fuel cell powered vehicles because they have high gravimetric and volumetric capacities. However, the *rates* of dehydrogenation and rehydrogenation of these hydrides are typically much too slow to be compatible with proton exchange membrane fuel cell temperatures. The slow rates originate, at least in part, from the high activation energies for diffusion associated with the ionic and covalent bonds found in these materials. In contrast to metallic systems, ionic and covalent bonds are directional. Thus, the transition states for atomic rearrangement occur in particularly unfavorable bonding configurations. This increases the activation energies for diffusion and results in slow phase transformation and hydrogen sorption kinetics. Overcoming these kinetic limitations has become a critical element in the development of light-metal complex hydrides for practical storage applications. Small quantities of catalytic additives have been shown to greatly improve the rates of hydrogen exchange in MgH₂ and NaAlH₄. Another approach involves formation of nanoscale hydrides by incorporation into nanoporous scaffolds. The small pores of the scaffold limit the sizes of the hydrogenated and dehydrogenated phases and thus the diffusion lengths to nanoscale dimensions. These relatively short diffusion lengths reduce diffusion times and therefore, increase overall rates of hydrogen sorption. The size limitations also result in increased interfacial area between reacting phases, which improves hydrogen capacity retention during cycling. This talk will focus on the preparation, characterization, and hydrogen sorption behavior of LiBH₄, MgH₂ and NaAlH₄ incorporated into nanoporous carbon aerogels.