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New Compounds, New Chemistries, and Nanoconfinement: Advances in Complex Hydrides for Storing Hydrogen

The promise of hydrogen fuel cells for clean, efficient automotive propulsion has stimulated intense interest in high-performance on-board hydrogen storage. Storing hydrogen as a solid hydride is conceptually attractive because it offers greater volumetric hydrogen density than either compressed gas or liquid hydrogen. Light element hydrides based on $[XH_n]^-$ complexes such as lithium borohydride ($Li^+[BH_4]^-$) are at the forefront of research because of their high hydrogen weight percent; meeting practical thermodynamic and kinetic requirements remains challenging, however. Compatibility with fuel cell operating temperatures and pressures requires a thermodynamic enthalpy of hydrogen release DH ~ 35 kJ/mol H_2, whereas DH values are too high for most complex hydrides. Hydrogen release and refueling kinetics also tend to be slow in this class of materials. At GM our quest for improved hydride materials includes the discovery of new compounds such as quaternary Li-B-N-H compounds that release more than 10 wt% hydrogen when heated. We have also explored the phase behavior of new reaction chemistries that promote thermodynamically “destabilized” borohydrides, such as the $LiBH_4$ + ½ MgH_2 system which reversibly stores hydrogen with reduced DH compared to $LiBH_4$. Approaches to help mitigate slow kinetics have moved beyond nanoparticulate catalysts to encompass hydrides confined in nanoporous carbon aerogel scaffolds.

Dr. Pinkerton is a Technical Fellow in the Chemical Sciences and Materials Systems Laboratory at the General Motors Research and Development Center. He received his B.S. degree in Physics and Mathematics from the University of Nebraska “with Highest Distinction” in 1976, and his M.S. degree (1979) and Ph.D. degree (1981) in Physics from Cornell University. He joined the GM Research Laboratories in 1981. His current research activities comprise the synthesis and characterization of high capacity light element hydrogen storage materials, including quaternary Li-B-N-H compounds and destabilized light metal borohydrides. In 2004 he received a General Motors John M. Campbell Award for applying accurate gravimetric methods to the evaluation of hydrogen storage materials. His past research topics include Nd-Fe-B high energy product magnets, for which he received both a General Motors Charles H. McKuen Award and a Charles F. Kettering Award in 1987; magnetostrictive rare-earth-iron/metal composites; and superplastic and bulk amorphous materials.

Host:
Prof. David Sellmyer
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3:30 p.m.
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