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Xray-Raman Scattering studies of interface-induced high hydrogen and ion dynamics in nanocomposite energy storage materials

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The success of the energy transition hinges on the development of efficient energy storage materials and technologies to deal with the intermittency of energy from solar and wind. Metal hydrides (such as LiBH4, NaBH4, KH NaCB11H12, etc.), which are well known for their ability to reversibly store large amounts of hydrogen, have recently emerged as multi-functional energy materials[1-2] This is due to their attractive properties for a variety of energy storage/conversion applications, including reversible hydrogen storage, batteries and fuel cells (as electrodes and solid electrolytes or ionic conductors), superconductivity, and catalysis.[1-2] In all these applications, it is crucial to improve the properties of the pristine metal hydride. In this lecture, I will show how interfacial effects, arising from nanocomposite formation with mesoporous materials (oxides or carbon) can lead to profound improvements in the properties of metal hydrides in energy applications.[3-7] For instance, high hydrogen release/desorption kinetics in hydrogen storage applications and orders of magnitude increase in ionic conductivity for electrochemical applications. Using selected examples from these two applications, I will discuss our recent results on the use of Xray Raman Scattering (XRS) to probe the chemical nature of the metal hydride/oxide and metal hydride/carbon interfaces, and thereby unravel the origin of the profound interface-induced property enhancements in the nanocomposites.[8-10] I will highlight how the fundamental understanding from the XRS studies is beneficial for tuning interface effects, and thereby enabling the design of metal hydride-based nanocomposites with tailor-made properties for energy applications.[1,3-6]

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