I2CNER

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Discovering the Fundamental Mechanisms of Environmental Fracture

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The implementation of a Hydrogen Economy requires metal components performing in high pressures of hydrogen gas. These conditions are favorable for potential catastrophic failures due to hydrogen embrittlement. The recent failure of a hydrogen station fueling hose demonstrates the need for an understanding of hydrogen embrittlement at these high pressures.

To study the microstructural mechanisms of hydrogen-induced failure, focused-ion beam (FIB) fabrication was used to extract samples perpendicular to fracture surface features for study in the transmission electron microscope (TEM). This technique allows the examination of the salient microstructural features immediately beneath the fracture surface, and the correlation of these features to the fracture surface. In this talk, studies of the underlying microstructure associated with hydrogen-induced “quasi-cleavage” features in a ferritic and a martensitic steel, and intergranular failure of nickel will be described. It will be shown that it is not possible to determine the fracture process purely by examination of the fracture surface. It is the microstructure developing ahead of the crack tip, accelerated by hydrogen, which establishes the requisite conditions for the different fracture modes.