NEBRASKA CENTER FOR MATERIALS AND NANOSCIENCE
2015 SEMINAR SERIES PRESENTS

NCMN

NCMN

Professor Ian M. Robertson

Department of Materials Science and Engineering
University of Wisconsin–Madison

Hydrogen Embrittlement Understood

Professor Ian M. Robertson

Hydrogen embrittlement is ubiquitous, occurring in all but a handful of metals. Although the phenomenon is well documented, the root cause of hydrogen embrittlement at the fundamental level remains poorly understood. The primary candidate mechanisms in non-hydride forming systems are decohesion, which results from hydrogen reducing the cohesive strength of the lattice; and hydrogen-enhanced localized plasticity, in which hydrogen attached to the dislocation shields its interaction with other elastic obstacles. The latter mechanism is supported directly by experiment, but the connection between hydrogen enhancing the velocity of dislocations and hydrogen-induced failure has remained tenuous.

Recent advances in experimental tools are providing new opportunities to discover the fundamental processes responsible for hydrogen-induced failure. Using these new tools, it has been found that hydrogen accelerates the evolution of the microstructure and stabilizes it in unanticipated states. Based on these observations, it is proposed that hydrogen accelerates the evolution of the dislocation microstructure by the hydrogen-enhanced plasticity mechanism, which work hardens the matrix to an unexpected degree at low strains and stresses and it redistributes the hydrogen to regions of greatest dislocation activity. It will be demonstrated that these two consequences dictate the fracture mode and the fracture path. These observations suggest a possible metallurgical solution to producing alloys with a higher tolerance to hydrogen.

IAN M. ROBERTSON is the Dean of the College of Engineering and a professor in Materials Science and Engineering as well as Engineering Physics at the University of Wisconsin-Madison. His research focuses on the use of the electron microscope as an experimental laboratory in which dynamic experiments can be conducted to reveal the atomistic processes responsible for the macroscopic response of a material. He has applied this technique to enhance our understanding of the reaction pathways and kinetics that occur during deformation, phase transformation, irradiation and hydrogen embrittlement of metallic materials. His insight to the mechanisms responsible for hydrogen embrittlement of metals was recognized by the Department of Energy in 1984 when he, along with Howard Birnbaum, received the DOE prize for Outstanding Scientific Accomplishment in Metallurgy and Ceramics. In 2011, he received the DOE EE Fuel Cell Program award for contributions to our understanding of mechanisms of hydrogen embrittlement. He was selected recently as the 2014 recipient of the ASM Edward DeMille Campbell Memorial Lectureship. He is the Editor-in-Chief of the review journal Current Opinion in Solid State and Materials Science.

Host:
Professor Bai Cui

Department of Mechanical & Materials Engineering

Wednesday, November 18, 4:00 pm
136 Jorgensen Hall
3:45 – refreshments in Jorgensen Atrium

Please Post