Discovering the relationship between evolved microstructure and mechanical properties

I.M. Robertson
Department of Materials Science and Engineering and College of Engineering
University of Wisconsin – Madison.

The behavior and properties of dislocations in metallic systems are assumed to be well understood. Based on this assumption, relationships between dislocation structures, fracture events and mechanical properties have been proposed. However, recent advances in experimental methods have provided an opportunity to explore at the nanoscale the dislocation microstructure that resides immediately ahead of propagating cracks as well as beneath fracture surfaces. The observed microstructures exhibit a degree of complexity not envisioned by our past a posteriori analysis approach. These findings have significant implications as to the suitability and applicability of conventional interpretations imbedded in the decohesion vs. HELP approach for predicting and assessing hydrogen-induced failures of metallic systems.

In this talk, I will demonstrate how the microstructure evolves under different loading conditions and environments. In particular I will establish that, contrary to previous assumptions, plasticity does play a deterministic role in environment-induced intergranular failure. The findings have significant ramifications for physically-based models of mechanical properties as well as alloy design.