Institute for Materials Science

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IMS Rapid Response 2018 * Recipient Guest Seminar

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Department of Engineering Physics
University of Wisconsin-Madison

Understanding Hydrogen-induced Intergranular Failure

Tuesday, April 17, 2018
10:00 - 11:00 AM
MSL Auditorium (TA-03 - Bldg 1698 - Room A103)

Abstract: Hydrogen embrittlement of metals causes a sudden catastrophic failure in most pure metals and alloys. The embrittlement can be accompanied by a transition in failure mode from ductile transgranular to intergranular. This transition has traditionally been explained by a simple reduction of the cohesive energy of the grain boundary by the segregated hydrogen. In this talk it will be shown, through molecular dynamic computer simulations in Ni and Fe, that segregated hydrogen is necessary but, by itself, not sufficient to cause grain boundary failure. The driving force behind the transition will be identified through a multi-scale experimental study of hydrogen embrittlement of Ni and the FCC equi-molar multi-component alloys NiCoFeCr and NiCoFeCrMn. The observation of hydrogen embrittlement in the multi-component alloys will dispel the claim that these alloys are unique in being immune to hydrogen embrittlement. It will be demonstrated that hydrogen-accelerated plasticity processes enhance the evolution of the microstructure, generating structures that are more common at higher levels of plastic strain. This evolution generates local orientation variations within a grain, and unexpectedly modifies, the distortion of grains along the tensile axis and texture evolution. From these results, the case for hydrogen-enhanced plasticity generating a new constraint on the grain boundary that promotes failure of the hydrogen-weakened boundary will be presented. The identification of this constraint provides a new driving force for the hydrogen-induced transition in failure mode.

Bio: IAN ROBERTSON is the dean of the University of Wisconsin-Madison College of Engineering. From 2011-13, Robertson was director of the Division of Materials Research for the National Science Foundation. From 2003-2009, he served as department head for the Department of Materials Science and Engineering, University of Illinois. He has been a member of the materials science faculty since 1983. Robertson's research focuses on how microstructure evolves in materials exposed to extreme conditions— stress, strain rate, gaseous and chemical environments and radiation—to enhance understanding of macro-scale property changes. He is author of more than 240 research publications on materials science topics and was named fellow of ASM International in 2009. Robertson has received numerous teaching and research awards, including DOE awards for outstanding scientific accomplishment in metallurgy and ceramics (DOE Basic Energy Sciences, 1982) for contributions to our understanding of mechanisms of hydrogen embrittlement (DOE EE Fuel Cell Program, 2011), and is the 2014 recipient of the ASM Edward DeMille Campbell Memorial Lectureship. He received his bachelor's in applied physics, Strathclyde University, Glasgow, Scotland in 1978; and Doctor of Metallurgy, University of Oxford, Oxford, England, in 1982.

To be on Prof. Robertson's Agenda, to participate in the Early Career Lunch, or for general information contact:
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