Mechanical & Materials Engineering *Pierson Graduate Seminar*

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Microstructure-Property Relationship of Advanced Materials for Extreme Environments

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Future advanced energy and aerospace technologies will place increasing demands on materials performance with respect to extremes in temperature, chemical reactivity, radiation flux, stress, and strain. The fundamentals of how extreme environments interact with materials can be used to develop new materials for these applications. To gain such information, advances in characterization tools are needed to permit multi-scale analysis of materials in-situ.

In this talk, I will first present the microstructural evolution of MAX phase ceramic materials in the high-temperature oxidizing atmosphere. It shows that Ti_2AlC MAX phase can be used without oxidation damage at below 1400 ºC. A protective α-Al_2O_3 layer can form at these temperatures. Above 1400 ºC, the oxide scales become cracked due to thermal stresses generated during cooling and growth stresses generated during the isothermal oxidation treatment (Acta Materialia, 2012, 60, 1079-1092).

The second part will focus on the basic mechanism of irradiation-assisted stress corrosion cracking of austenitic stainless steels. In this study, we have ascertained how the presence of irradiation damage influences the criteria for predicting slip transfer across grain boundaries. The importance of the local resolved shear stress increases as the dislocations must experience sufficient shear stress to propagate through the irradiation damage field. If the grain boundary cannot transfer the slip, it will adopt an alternate relief mechanism such as crack nucleation (Acta Materialia, 2014, 65, 150-160).

Biosketch

Dr. Bai Cui is a research associate in Prof. Ian Robertson's group at the University of Illinois at Urbana-Champaign. He received his PhD in Materials from Imperial College London, UK, and his B.E. and M.E. in Materials from Tsinghua University, China. His research is focused on the microstructure-property relationship of advanced materials used in the extreme environments encountered in advanced energy and aerospace applications. His PhD thesis is on the development of the MAX phase high-temperature ceramics. His postdoc research is on the irradiation-assisted stress corrosion cracking of austenitic stainless steels used in the light water reactors. In 2012, he received the Richard Brook Prize for Best PhD in Ceramics in the UK and the Guastv Eirich Award from European Centre for Refractories. Other honors include the Tony Evans Prize for Best Ceramics Thesis (2012), the Lee Family Scholarship (2008-2011) and an Outstanding Master's Thesis Award (2008).

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