COLLEGE OF ENGINEERING
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ME Department Seminar

An Integrated Experimental and Computational Approach to Microstructure-Property Relationships in Structural Materials

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Abstract

Most modeling approaches to microstructure-property relationship utilize highly simplistic descriptors of microstructures (such as average particle size and volume fraction) that are empirically correlated to the properties (e.g., cutting vs. looping). ICME will remain empirical data driven with limited predicting power and payoffs without modeling capabilities that incorporate specific transformation and deformation mechanisms operating in specific alloy systems under a given set of processing parameters, microstructure states and service conditions. In this presentation, we focus on what one could do at the mesoscale to address this difficult challenge and develop mechanism-based and microstructure-sensitive modeling tools. In particular, using Ni-base superalloys as examples we demonstrate how to integrate mesoscale modeling with experimental characterization and use phase-field method to bridge *ab initio* calculations and crystal plasticity simulations to (a) identify transformation / deformation mechanisms and quantify activation pathways, and (b) provide "mechanism maps" and constitutive laws for microstructure evolution and dislocation – microstructure interaction as function of alloy composition, thermomechanical history, temperature and loading condition. The work is supported by the National Science Foundation under the DMREF program

Bio

Professor Wang received his B.S. (1982) in Metallurgy from Northeastern University of China and Ph.D. (1995) in Materials Science and Engineering from Rutgers University in the US. He joined the MSE Department at The Ohio State University (OSU) in 1996 as an assistant professor and became a full professor in 2005. His research interests are in the field of theoretical modeling and computer simulation of microstructure evolution during phase transformations and plastic deformation in high temperature Ni-base superalloys, Ti-, Al- and Mg-alloys, ferroic functional materials and metallic glasses. He is at the forefront of developing and applying mesoscopic modeling approaches (in particular the phase-field method and its integration with atomistic and continuum approaches) for both fundamental and applied research. He has developed strong collaborations with many experimental groups to motivate and validate his modeling work. Prof. Wang has received numerous awards including CAREER Award (1997) from NSF, KC Wong Research Award (2005) from Education Foundation of Hong Kong, Hsun Lee Research Award (2006) from Institute of Metal Research, Chinese Academy of Science, ARC International Fellow (2009) from Australian Research Council, Harrison Faculty Award for Excellence in Engineering Education (2010) from OSU, Fraunhofer Bessel Research Award (2012) from Alexander von Humboldt Foundation of Germany, and Prof. Brahm Prakash Visiting Chair (2014) from Indian Institute of Science. Prof. Wang has published ~ 190 refereed journal articles (~ 90 in Acta Materialia).