

## Distinguished Lecture Series

presents

### “Mechanisms for Diffusion Dependent Interfacial Strain: New Insights for Ultrahigh Temperature *In Situ* TEM”

**Professor Shen J. Dillon**

University of California Irvine

#### ***Abstract***

Polycrystals can exhibit high temperature interface mediated strain in response to an externally applied stress, such as creep, superplasticity, or hot-press sintering, or an internal stress, such as stress relaxation at interfaces during thermal cycling or oxide scale growth, fission bubble growth, and densification during sintering. Such problems have mostly been analyzed and treated in the context of purely diffusional models. The diffusional flux, however, is one of only three necessary steps or conditions required for diffusional dependent interfacial strain, the other two include interfacial dislocation nucleation and the emission and absorption of point defects at the interfacial dislocations. The prevalence of diffusional rate limited models results from somewhat unsubstantiated assumptions within the early literature along with the non-uniqueness of the various rate limiting kinetic models, i.e., disparate models often fit isothermal kinetic data obtained from polycrystalline experiments equally well.

Our group developed a laser heating-based approach for ultrahigh temperature in situ transmission electron microscopy (TEM) during small-scale mechanical testing. This approach enables more direct characterization of interfacial strain kinetics and thermodynamics at individual grain boundaries, which provides an improved basis for evaluating the high temperature deformation mechanisms. This talk will present experiments that reveal grain boundary dislocation nucleation limits interfacial strain kinetics in many systems up to relatively large stresses, i.e.,  $\approx 108$  Pa. Based on the experimental observations, new models for sintering and grain boundary creep are developed to account for the appropriate mechanism. These are demonstrated to fit experimental data well, predict broad trends in the literature, and provide explanations for several poorly understood phenomena within the sintering and creep literature. The talk will conclude by discussing broader implications of the new scientific understanding.

#### ***Biography***

Shen J. Dillon is a Professor in the Department of Materials Science and Engineering at the University of California Irvine. He received his B.S. and then Ph.D in Materials Science and Engineering from Lehigh University in 2007. He began as an Assistant Professor at the University of Illinois at Urbana-Champaign in 2009 and joined the faculty at UC Irvine in 2021. His scientific interests relate to understanding the key role played by inorganic interfacial structure-property relationships in affecting the performance of systems in extreme environments. Much of his recent work relates to developing and applying novel in situ characterization techniques that can be applied to understanding the dynamic properties of materials and their interfaces. He is the author of over 100 articles, and was a recipient of the 2011 Department of Energy Early Career Award, the 2013 National Science Foundation CAREER Award, and the 2015 American Ceramic Society's Robert L. Coble Award for Young Scholars.



**October 18, 2022**

**4:00P.M.**

**Location: ZHS 352**