UNIVERSITY OF CALIFORNIA
UC RIVERSIDE | Materials Science and Engineering

Winter 2020 COLLOQUIUM SPEAKER

How big should your nanoindentation be? The implications of indentation size (and side) effects in assessing the properties of small volumes.

Drivers for testing small volumes of materials for assessing the mechanical properties are either (1) the sample you want to test is very small in the first place, such as measuring the hardness of a wear resistant coating which is in thin film form or (2) you can well-characterize a small volume or the small volume has some spatially distinct feature, such as probing properties near a grain boundary. Small scale mechanical testing using instrumented indentation is one commonly applied method. Indentation testing requires minimal sample preparation and has high spatial fidelity, but creates complex loading states over uniaxial or biaxial applied stress methods. However, the ease of use and wide range of samples which are amenable for indentation testing has made this a common tool both for experimental assessment studies and for experimental validation of providing comparisons to simulations and predictions of mechanical properties.

This presentation will focus on three systems of interest that exemplify the ways instrumented indentation can be used to extract information regarding material properties and structures. First, for a case where samples are small, an experimental study of the elastic and plastic deformation mechanisms in small molecular crystals will be presented. Energetic and pharmaceutical materials are often non-cubic molecular crystals with complex polymorphs that exhibit brittle mechanical behavior, making machining test samples difficult. Testing sub-mm crystals, and accounting for orientation effects, will be shown and validated versus large crystals. The second and third systems of interest will be metallic materials, with sparse defects, and a modern dual phase steel. The effects of dislocation density on both yield behavior and subsequent plastic deformation, and the ability to probe spatially varying properties will be evaluated. Addressing indentation size effects in how to best describe "bulk" properties with a small test will be shown on several transition metals, and the impact of stacking fault energy on the perceived indentation size effect will be shown to be less important that the presence of pre-existing defects.

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Prof. David Bahr is currently the Head of Materials Engineering at Purdue University. Prior to this position he was Director and Professor of Mechanical and Materials Engineering at Washington State University. He received his BS and MS in MSE at Purdue University, and a PhD in Materials Science at the University of Minnesota. He worked for a short time at Sandia National Laboratories during his PhD before starting as a faculty member in the School of MME at WSU in 1997. In 2000 he won the Presidential Early Career Award for Scientists and Engineers for his work with Sandia on DOE stockpile stewardship, in 2003 he received the Bradley Stoughton Award from ASM International, and in 2007 received the Robert Lansing Hardy award from TMS (where he served as a member of the board of directors from 2012-2015). He has published over 190 papers in the literature and given over 40 invited talks and seminars. He is a Fellow of ASM International and of AAAS.

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