Measurement of Power Law Creep Parameters by Nanoindentation

Over the past decade, great progress has been made in making small-scale mechanical property measurements by nanoindentation at elevated temperatures; in fact, several systems for doing so are now commercially available. These advances have paved the way for studying and measuring the material parameters that describe power law creep behavior, e.g., the stress exponent for creep, \( n \), and the activation energy for creep, \( Q_c \), using small-scale experiments. The ability to make such measurements with nanoindentation provides for high point-to-point spatial mapping as well as the characterization of thin films and thin surface layers. However, serious experimental difficulties are encountered in making such measurements, particularly those associated with thermal drift, and how one converts the data obtained in nanoindentation testing to the parameters used to characterize uniaxial creep is not at all straightforward. In this presentation, we discuss recent progress in making meaningful measurements of power law creep parameters by nanoindentation. Special attention is given to the models and data analysis procedures needed to convert nanoindentation load-displacement-time data to the parameters normally measured in uniaxial tension or compression tests. * Research sponsored in part by the National Science Foundation under grant number DMR-1427812.

Bio: George M. Pharr is TEES Distinguished Research Professor in the Department of Materials Science and Engineering at Texas A&M University, College Station, TX. He received his BS in Mechanical Engineering at Rice University in 1975 and Ph.D. in Materials Science and Engineering from Stanford in 1979. After one year of postdoctoral study at the University of Cambridge, England, he returned to Rice in 1980 as a faculty member in the Department of Mechanical Engineering and Materials Science. In 1998, he moved to the Department of Materials Science and Engineering at the University of Tennessee (UT), where he served as Chancellor's Professor and McKamey Professor of Engineering. While at UT, he also held a Joint Faculty Appointment at the Oak Ridge National Laboratory (ORNL). He was Head of the UT Materials Science and Engineering Department during 2006-2011 and Director of the UT/ORNL Joint Institute for Advanced Materials from 2009 to 2016. He moved to his current position at Texas A&M in January 2017 as part of the Texas Governor's University Research Initiative. Dr. Pharr received ASM International's Bradley Stoughton Award for Young Teachers of Metallurgy in 1985. His honors also include the Amoco Award for Superior Teaching at Rice University in 1994, a Humboldt Senior Scientist Award in 2007, the Materials Research Society's inaugural Innovation in Materials Characterization Award in 2010, and the University of Tennessee Macebearer Award in 2015. He is a member of the National Academy of Engineering (2014) and a Fellow of ASM International (1995), the Materials Research Society (2012), and TMS (2016). Dr. Pharr has been an Associate Editor of the Journal of the American Ceramic Society since 1990 and Principal Editor of the Journal of Materials Research since 2012. He is an author or co-author of more than 200 scientific publications, including 4 book chapters. His research focuses on mechanisms of plasticity and fracture in solids, especially at small scales.