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Dr. Suneel Kodambaka

Associate Professor
Department of Materials Science Engineering,
University of California Los Angeles

In situ microscopy: a powerful approach for understanding materials phenomena

In situ real-time observations of materials synthesis and/or response to applied (e.g., thermal, mechanical, or electrical) stimuli with high spatial and temporal resolutions can facilitate quantitative description of the observed phenomena. Probably, the most attractive aspect of in situ studies is that it enables visualization of transient and, often, unexpected processes occurring in the materials. In this talk, I will showcase in situ scanning tunneling microscopy (STM) and transmission/scanning electron microscopy (TEM/SEM) as viable and powerful characterization techniques for studies of the growth kinetics of two-dimensional (2D) layered materials and mechanical behavior of refractory transition-metal carbides.

As representative examples, I'll present recent results from our in situ variable-temperature STM studies of the growth of 2D graphene and hexagonal boron nitride (hBN) layers on Pd(111) surfaces and in situ TEM and SEM studies of size- and orientation-dependent uniaxial compression of TaC and ZrC single-crystals. Our results provide new insights into the mechanisms controlling the growth of 2D layered materials and help identify the active slip systems and plastic deformation pathways in refractory carbides.

Suneel Kodambaka is currently an Associate Professor (and Professor starting July 1, 2019) in the Department of Materials Science and Engineering and the Area Director for Structural Materials for Master of Science in Engineering Online Program at the University of California Los Angeles (UCLA). Suneel graduated with a bachelor of technology degree (B.Tech.,) from the Indian Institute of Technology, Madras, M.S., from Southern Illinois University at Carbondale (SIUC), and Ph.D. from the University of Illinois, Urbana-Champaign (UIUC). Suneel is a recipient of the 2010 Alumni Achievement award from the SIUC College of Engineering, 2009 AVS Thin Film Division's Paul Holloway Young Investigator Award, and 2008 Best Paper award from the IBM Materials Research Community. His research relies on in situ microscopy (SEM, TEM, LEEM, and STM) studies to develop fundamental understanding of the nucleation and growth kinetics and thermo- chemical and mechanical stabilities of crystalline solids. Suneel can be reached at Kodambaka@ucla.edu.