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Mechanical Engineering Seminar Series

Multiscale Understanding of Confined Volume Enabled Unusual Plasticity in Nanocomposites

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Room 2505 GG Brown

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ME Seminar Zoom link

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Abstract
Nanoscale dual-phase alloys composed of alternate metal (soft) and intermetallic or covalently bonded (hard) strengthening phase exhibit high strength, high strain hardening rate, and measurable plasticity at ambient and elevated temperatures. Here we report unusual plasticity carriers in intermetallic Al 2 Cu and covalently bonded Silicon in Al-Si and Al-Cu alloys based on multiscale experiments and modeling. Plastic deformation commences in soft phase associated with the nucleation and gliding of dislocations. Hard strengthening units act as strong barriers for the motion of dislocations in soft phase. As a result, the propagation of dislocations is confined in the soft phase, resulting in dislocation deposition and accumulation in the soft/hard phases interfaces. Particularly due to the geometric compatibility between adjacent phases, the hard phase elastically deforms to accommodate the elastic and plastic deformation in the soft phase. Consequently, strain hardening develops in the soft phase associated with back stress due to the plastic deformation incompatibility between adjacent phases, and high stress develops in the hard phase. The high stress may trigger unusual shear in hard phase (plastic co-deformation) or instability such as bending and kinking (instability) and cracking in hard phase (failure). Cracks in hard phase initiate by the increased tensile stress due to loading transfer in tension test or bending induced tensile stress in compression test. These mechanical behaviors are strongly related to the plastic deformability and the characteristic dimension of the hard phase.

Bio
Dr. Jian Wang is a Fellow of ASME, a Fellow of ASM International, and Wilmer J. and Sally L. Hergenrader Presidential Chair of Mechanical and Materials Engineering at the University of Nebraska-Lincoln. He received his Ph.D. from Rensselaer Polytechnic Institute, Troy, NY, USA, in 2006 and worked at Los Alamos National Laboratory (LANL) until 2015. His research focuses on quantitatively exploring the structure-properties relations of materials using multi-scale theory, modeling, and experimental methods and techniques. He was awarded the LANL Distinguished Postdoctoral Performance Award (2009), the LDRD/Early Career Award (2011), TMS MPMD Young Leader Award (2013), the International Plasticity Young Research Award (2015), Materials Today Rising Star Award in the category of Materials Genome Innovation (2018), TMS MPMD Distinguished Scientist Award (2022) and TMS BRIMACOMBE MEDALIST Award (2023). He served on the Editorial Board of the International Journal of Plasticity (2015~), Materials Research Letters (2016~), and others. He has published more than ~300 peer-reviewed papers (> 18,000 citations and H-index = 728; 9 papers featured as Journal cover), and delivered 150+ invited/keynote lectures.

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