

Mechanical Engineering Seminar Series

March 3, 2026, 11:00AM

Dean's Conference Room, E-203E

Title: New Materials Processing via Electro-Nano-Pulsing (ENP)

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Abstract: This project focuses on developing Electro-Nano-Pulse (ENP) technology, an innovation in electric field-assisted material processing. The objective is to investigate interactions between ultra-intense nanopulse electric currents and grain boundaries (GBs) in crystalline materials, enabling precise control over defect structures such as GB complexions and morphologies. Unlike conventional methods that primarily alter bulk material properties, ENP targets localized GB regions at the atomic level, offering unprecedented control over material structure. This technology uniquely modifies material properties by selectively influencing crystalline heterogeneities, including dislocations, grain boundaries, and interfaces. By enabling precise defect-level modifications - such as engineered grain boundary networks, record-high dislocation densities, and novel crystal discontinuities - ENP has the potential to revolutionize materials processing. The project integrates computational and experimental approaches. Atomistic simulations, employing a bicrystal grain boundary model, will distinguish between thermal (Joule heating) and nonthermal (electric field) effects on GBs. An advanced ENP system will be developed to generate ultra-intense nanopulses across various environments, including a Cryo-ENP setup utilizing liquid nitrogen, to validate simulation results. This novel approach has far-reaching implications for materials design, enabling the fabrication of superhard fracture and corrosion-resistant materials, as well as advanced nanocoatings and nanoporous battery materials. This project will lead to the creation of materials with unprecedented strength, durability, and functional capabilities, with transformative applications in aerospace, energy, and manufacturing industries.

Bio: Dr. Wenwu Xu received his Ph.D. in Materials Science and Engineering from Beijing University of Technology (China) in 2011. He then pursued postdoctoral research at Friedrich-Schiller-Universität Jena (Germany) in 2012 and The University of Manchester (U.K.) in 2013-2015. In 2016, he joined the Department of Materials Science and Engineering at the University of California, Merced as a postdoc and then as a lecturer. In 2017/08, Dr. Xu joined the Department of Mechanical Engineering at San Diego State University as an Assistant Professor. Dr. Xu's research interests include computational Multiscale Modeling of Materials (continuum, microscopic, atomistic, and quantum mechanics) and characterization of material microstructure at multiple scales from 2D (electron microscopy) to 3D (synchrotron X-ray computed tomography), and 4D (time-resolved tomography). His research emphasizes the coupling of experimental and theoretical investigations to reveal complex structural and functional behavior of material systems at the nanoscale.

