In-situ high resolution TEM for interface and nanocrystal processing, electric shock failure and lithium-ion battery characterization

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TUESDAY, January 21st @ 2:00 pm in BRK 1001
Coffee and snacks served before seminar
also on MS Teams

Abstract:

This talk will cover the recently-developed in-situ high resolution transmission electron microscopy (TEM) for interface and nanomaterials processing, dynamic mechanical straining, heat treatment and electrochemical lithiation with focus on controlled - grain boundary (GB) processing, monatomic metallic glass synthesis, atomistic observation on GB-mediated deformation, friction, grain boundary migration and phases transformation. Deformation mechanisms (twinning, diffusion-controlled dislocation slip, shear-driven amorphization) of metallic FCC, BCC and Si nanocrystals as function of crystal size, surface and orientation will be revealed. For advanced metallic glass processing, in-situ TEM on vitrification of single-element metallic liquids to form monatomic metallic glasses by achieving an unprecedentedly high liquid-quenching rate of 1014 K/s will be presented. Melts of pure refractory tantalum and vanadium are successfully vitrified through liquid/solid interface driven process. With in situ the TEM, we investigated the formation condition of the monatomic metallic glasses as obtained. The availability of monatomic metallic glasses, being the simplest glass formers, offers unique possibilities for studying the structure and property relationships of glasses. The ultrahigh cooling rate makes it possible to explore the fast kinetics and structural behavior of supercooled metallic liquids within the nanosecond to picosecond regimes. Expectation for the future of the in-situ TEM technique on interface processing including electric-shock mediated GB migration, electrochemical lithiation reaction interface for lithium-ion battery development and atomistic 3D printing process, shock-mediated semiconductor device failure under TEM will be covered.

Bio:

Dr. Scott Mao is Professor of Materials Engineering at Purdue University. Dr. Mao's contributions include deformation and fracture physics of metals, nanocrystalline, intermetallics and piezo- and ferroelectric ceramics, innovative in situ high resolution transmission electron microscopy for studying atomistic processes of deformation twinning and dislocation nucleation, phase transformation, inter-atomic friction, electrochemical-lithiation mediated plasticity in electrodes, monoatomic metallic glasses synthesis through in-situ ultrafast liquid quenching and in-situ grain boundary processing / migration with over 300 publications (H-index 73, citation: ~24,139). He did Ph.D in Tohoku University, post-doc. in Massachusetts Institute of Technology, John Swanson endowed professor at U. of Pittsburgh, U. of Calgary, and visiting faculty at Harvard University. He has given over one hundred keynote, plenary, and invited talks in TMS, MRS and ASME symposiums, and serves as Editor in-Chef, and Editor of International Journal of Metallurgy and Metal Physics, and Advances in Materials Research respectively. Dr. Mao is elected fellow of Royal Society of Canada, Canadian Academy of Engineering, TMS, APS, IAAM, ASME and Vebleo, awards recipient of the University of Pittsburgh Chancellor's Distinguished Research, the Metal Physics Award (CIM) and William Kepler Whiteford endowed Professor.

Host: Neil Dilley, Research Manager | Email: ndilley@purdue.edu