FALL 2023

MSE 690 SEMINAR SERIES

MONDAY, SEPTEMBER 11TH | 3:30 REFRESHMENTS | 3:45PM SEMINAR | ARMS 1010

SCOTT MAO

John Swanson endowed professor in Department of Mechanical Engineering and Materials Science

University of Pittsburgh

"In-situ transmission electron microscopy on controlled grain boundary processing and deformation of nanocrystals"

Abstract: This talk will cover the recently-developed in-situ high resolution transmission electron microscopy (TEM) for dynamic mechanical straining, heat treatment and electrochemical lithiation with focus on controlled - grain boundary (GB) or interface 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.

Prediction 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 under microscope will be covered.

Biography: Dr. Scott Mao was John Swanson endowed professor in Department of Mechanical Engineering and Materials Science at University of Pittsburgh, a pioneer in in-situ high resolution transmission electron microscopy on atomic scale mechanical behavior, grain boundary processing and monatomic metallic glasses synthesis with over 300 publications (H-index 70, citation: 21,431). He did Ph.D in Tohoku Univ.(1988), post-doc. in MIT (1989) and visiting faculty at Harvard Univ.(1995). 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 Canadian Academy of Science (RCS), Canadian Academy of Engineering, APS, IAAM, ASME and Vebleo, awards recipient of the TMS-SMD, the Chancellor's Distinguished Research, the Metal Physics (CIM) and William Kepler Whiteford endowed chair.

Dr. Mao's early contributions include deformation physics and fracture of metals, nanocrystalline, intermetallics and piezo- and ferroelectric ceramics. innovative in situ high resolution TEM technique for studying atomistic processes of phase transformation, inter-atomic friction, electrochemical-lithiation mediated plasticity in electrodes and monoatomic metallic glasses process through in-situ ultrafast liquid quenching.

PURDUE UNIVERSITY

School of Materials Engineering