APS Scientific Computation Seminar Series

Speaker: Wei-Ying Chen
Materials Scientist
Nuclear Science and Engineering Division
Argonne National Laboratory

Title: In-situ TEM of the Radiation Effects on Material Microstructures in IVEM-Tandem Facility: Overview and Recent Development

Date: September 26, 2022
Time: 1:00 p.m. (Central Time)

Location: https://argonne.zoomgov.com/j/1615356746
Meeting ID: 161 535 6746
One tap mobile
+16692545252,1615356746# US (San Jose)
+16468287666,1615356746# US (New York)
Dial by your location
+1 669 254 5252 US (San Jose)
+1 646 828 7666 US (New York)
+1 551 285 1373 US
+1 669 216 1590 US (San Jose)
Meeting ID: 161 535 6746
Find your local number: https://argonne.zoomgov.com/u/ady6YUF12g

Hosts: Mathew Cherukara and Nicholas Schwarz

Abstract: The IVEM-Tandem Facility at Argonne National Laboratory is a leading user facility for *in-situ* TEM study of the radiation effects on material microstructures. It interfaces a 500 kV ion accelerator and a 20 kV helium ion source to a 300 kV Hitachi H-9000NAR TEM, allowing real-time microscopy under dual-beam ion irradiation damage/implantation with well-controlled conditions (specimen orientation, temperature, ion type, ion energy, dose, dose rate, applied strain). The superior electron brightness of LaB_6 filament of the H9000 microscope makes it suitable for diffraction contrast imaging, permitting effective real time observation of the irradiation-induced defects in nanoscale. The IVEM-Tandem Facility was commissioned in 1995 in Material Science Division as part of the Electron Microscopy Center. Currently, it was transitioned to Nuclear Science and Engineering Division, supported by DOE Office of Nuclear Engineering. In FY17-FY20, it provided access to more than 20 user groups worldwide (65 awarded proposals) through Nuclear Science User Facility Program. The first part of the presentation today will give an overview of the capability of IVEM-Tandem Facility and the research conducted here, including fundamental studies of defect formation and evolution, tomography of defect distribution, phase stability and computer modeling and simulation in basic materials, advanced alloys, accident tolerant fuels and storage of spent nuclear fuels. The second part of the presentation is about our recent efforts to implement computer vision (CV) in *in-situ* TEM studies. TEM videos of *in-situ* ion irradiation experiments provide dynamic information of microstructural evolution that cannot be obtained from post-irradiation examinations. However, a dauntingly huge amount of video data has practically inhibited manual analysis, often leaving valuable dynamic information under-utilized in the past. To overcome the challenge, we took advantage of the recent advance in CV to fully exploit TEM video data. We will talk about two projects under development using semantic segmentation and multi-object tracking, respectively, to automatically analyze the evolution of irradiation-induced voids and cascade-induced vacancy clusters in nickel irradiated with 1 MeV krypton ions at between 550ºC to 700ºC. The nucleation, growth, coarsening and shrinkage of individual defect clusters were analyzed frame by frame. The application generates a unique data set that is rarely available before, and it enables a new way to measure the dynamic properties of materials under irradiation environments.