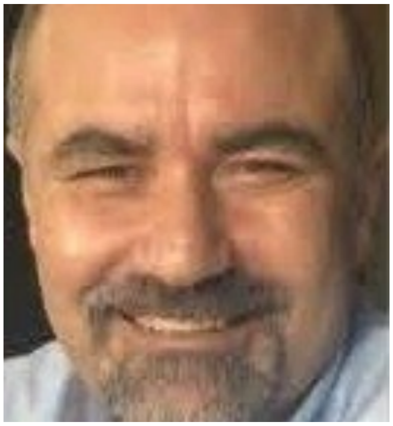
PURDUE UNIVERSITY | School of Nuclear Engineering

Nuclear Engineering Seminar

Dr. Anter El-Azab,

Professor of Materials Science, Purdue University



Anter El-Azab is a professor of Materials Science and Engineering at Purdue University. He obtained his doctorate degree in Engineering at the University of California, Los Angeles. Prior to coming to Purdue, he joined Pacific Northwest National Laboratory as a research scientist, and was a professor of Mechanical Engineering, Materials Science and Engineering and Computational Science at Florida State University. His current research focuses on the mechanics and physics of defects in materials and the influence of defects on materials properties. His latest research covers statistical modelling of dislocations and continuum dislocation dynamics, microstructure evolution in materials including thin films, radiation effects in nuclear materials, and thermal transport in defective solids. Part of his research is dedicated to the development of theoretical formalisms and computational and data science methods for multiscale and multi-physics modelling of materials, as well as the development of algorithms for bridging modelling and experiments in materials research.

Wednesday, September 24, 2025

3:30 pm | WTHR 200

Toward a mechanistic understanding of the plastic strength of irradiated ferritic alloys for fusion

Abstract

ODS ferritic and reduced activation ferritic-martensitic steels, as Eurofer-97, LF-1 and MA957, represent leading candidate alloys for nuclear fusion. This interest in these alloys is due to their superior mechanical properties and irradiation stability. These steels are predominantly made of Fe and Cr, with the latter being 8-14 wt.% of the alloy. It has been observed that Fe-Cr alloys exhibit composition fluctuations and microstructure changes, primarily prismatic loops formation, when exposed to neutron or ion irradiation. Both composition changes and prismatic loops impact the plastic strength of these alloys. I will summarize our recent investigations of the effects of composition fluctuations on the yielding strength, focusing on two areas: (1) Reworking the classical theory of spinodal strengthening in alloys with coherent long-range composition undulations [1,2] to demonstrate the impact of composition changes on strength in these alloys. (2) Using dislocation dynamics simulations to probe the collective dynamics of dislocations near the yield point in irradiated alloys by looking at the effect of prismatic loops and the combination of loops and composition fluctuations on strength of FeCr and FeCrAl alloys near yielding. It will be shown that, in the presence of composition fluctuations, the strength of BCC ferritic alloys is no longer dominated by the ability of screw dislocations to move. We will also show that the that the hardening by dislocation loops is a threshold-type effect, requiring the build-up of the density of loops up to certain values for the yield strength of be impacted. Lastly, we will interpret the composition-dependent stress-strain behavior of FeCr alloys via our composition-aware dislocation dynamics and explain the synergy between solute hardening and strain hardening based on mesoscale information obtained from dislocation dynamics simulations. The research paves the way toward a physics-based understanding of alloy strength under irradiation, while explicitly accounting for the alloy composition.