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Séminaire Seminar

E&E Energie & Environement
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Understanding radiation tolerance and materials design via advanced characterization and modern data analysis methods

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Visio via Zoom

Structural materials in future reactor systems, such as fusion reactors, will experience significantly severe irradiation conditions such as ~150-200 displacements per atom (dpa) end-of-life neutron doses, elevated operating conditions, and presence of harmful transmutation/corrosion species. Consequentially, designing and testing advanced radiation tolerant materials combined with their implementation in the reactor concepts is of pivotal importance. Specific to understanding fusion materials, a major challenge is the unavailability of a fusion prototypic neutron source where the structural materials can be tested and validated under relevant neutron spectrum. ORNL is equipped with a flux-trap type mixed-spectrum High Flux Isotope Reactor (HFIR) which boasts one of the highest steady-state neutron fluxes of any research reactor in the world. HFIR facilitates simulating fusion-relevant transmutation species generation rates (such as He) by using innovative isotopic modification approach while rapidly accumulating neutron dose at a typical rate of ~12-14 dpa/year. Using HFIR as a key irradiation platform, understanding how to tailor need-base materials' irradiated properties is presented via multi-faceted approach, that involves: (i) a thorough understanding of the irradiation damage phenomenon, (ii) modern materials design and manufacturing, (iii) use of state-of-the-art characterization and big data science techniques.

Here, advancements in our fundamental understanding of radiation tolerance obtained by informed microstructure characterization will be presented for HFIR neutron and ion irradiated nuclear structural alloys and ceramics. The materials will include Fe base nanostructured ferritic alloys, Fe-Cr alloys and highly promising transition metal ceramics. The talk will also present how combining novel electron microscopy techniques with modern data analysis and artificial intelligence (AI) enables bulk scale understanding of nuclear materials at atomic-to-nanometer scale precision.