Understanding Tritium Transport Behavior in Molten Fluoride-Salt and Graphite Systems

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Seminar Abstract:

Fluoride-salt cooled high temperature reactor (FHR) is the solid fuel salt-cooled reactor design and operates at atmospheric pressure with fluoride-salt as coolants and graphite matrix fuel pebbles containing TRISO fuel particles. Tritium control in FHR is one of the big challenges because tritium is produced in the primary coolant (FLiBe) by neutron irradiation, and tritium molecule readily diffuses through metallic heat exchanger tubes and tritium fluoride is highly corrosive to structural materials at FHR operating temperature. Due to the porous properties of graphite and large graphite surface area from fuel pebbles and replaceable nuclear graphite reflectors, it is expected that these in-core graphite components can provide significant removable tritium sink through chemisorption with the formation of C-H bonds. In FHR, a large amount of the graphite surface is in direct contact with the fluoride salt coolant. Graphite fluorination can occur by formation of C-F bond with unsaturated reactive carbon sites in graphite. High temperature and intense radiation (neutron or ionizing) cause more structural defects in graphite and contributes to the salt-graphite interaction. The interaction changes graphite surface chemistry and can change graphite wettability, which could induce fluoride salt intrusion into graphite bulk and it also affects tritium retention and diffusion in graphite eventually. In this study, microstructure characterization (X-ray diffraction, Scanning Electron Microscope/Energy-dispersive X-ray spectroscopy, Raman Spectroscopy) and elemental analysis techniques (Glow Discharged Mass Spectrometry, X-ray photoelectron spectroscopy, Inductively coupled plasma mass spectrometry) were used to study graphite chemical and microstructural change, to identify the formation of C-F bonds and to analyze impurity changes in graphite and fluoride salt. This seminar will describe the current status and future vision of the investigation of the interaction between graphite and FLiBe.

Presenter Biography:

Huali Wu is a PhD dissertator in the Engineering Physics Department at the University of Wisconsin-Madison working on experimental investigation of tritium transport in molten fluoride-salts and graphite systems. Prior to joining UW-Madison, she received her Bachelor's degree in Nuclear Science and Nuclear Technology at Harbin Engineering University in China in 2009, and Master's degree in Nuclear Engineering at Texas A&M University in 2013. Her research interest is graphite degradation in molten fluoride salts, material performances in extreme conditions and compatibility with coolants in advanced reactor designs, reactor safety, human factors and decision making.