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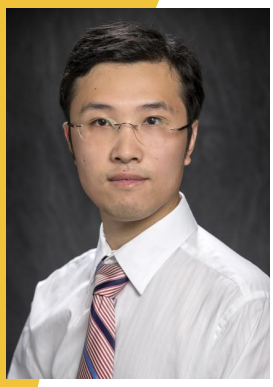

3:00-4:00pm, Friday, September 6, 2019
1263 Patrick F Taylor Hall

Fabrication and Radiation Stability of Apatite-based Ceramic Nuclear Waste Form

by Fengyuan Lu*

Louisiana State University

The disposal of long-lived radionuclides is one of the greatest technical challenges in nuclear energy. In order to effectively immobilize these radionuclides for long-term geological disposal, a systematic study of an apatite-based ceramic nuclear waste form is conducted. A two-step fabrication method combining high energy ball milling (HEBM) and spark plasma sintering (SPS) techniques is adopted, in which the HEBM process enables a low temperature (50 °C) solid state reaction to incorporate highly volatile fission products such as Iodine-129 in a vanadate apatite nanostructure with minimum iodine loss, and the subsequent SPS rapidly consolidates the powders into a crystalline ceramic form with high iodine loading and thermal stability. The radiation performance of the apatite-based waste form is investigated by energetic ion, electron and gamma ray irradiation experiments under various conditions. The radiation damage in apatite under displacive ions is remarkably suppressed at elevated temperatures due to dynamic defect annealing, and the material stability is further tuned by a strong nano-size effect and interface dependence. The study highlights that radiation stability can be tailored by material processing, microstructural manipulation and radiation conditions to achieve in the design of radiation tolerant materials for next generation nuclear systems.

* Dr. Fengyuan Lu is an Assistant Professor in Mechanical and Industrial Engineering at LSU. He received his B.S. in Electronics from Jilin University, China, in 2005, and his M.S. in Electronics from Peking University, China, in 2008. He received his Ph.D. in Nuclear Engineering from Rensselaer Polytechnic Institute, U.S., in 2012, with a thesis topic on the phase transformation and microstructural evolution of nanostructured oxides and nitrides under ion irradiations. After a post-doctoral appointment at Rensselaer Polytechnic Institute, he joined LSU in 2014. His current research areas cover advanced ceramic fabrication, radiation effects in solids, atomic scale defect analysis with positron annihilation lifetime spectroscopy, nuclear energy materials, energy storage and conversion materials, and ion beam modification. His research projects are funded by U.S. Nuclear Regulatory Commission (NRC), Louisiana Board of Regents (BOR), LSU Office of Research and Economic Development (ORED), and Chevron Innovative Research Funds.