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

by Fengyuan Lu*

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