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Correlating redox chemistry with microstructure evolution of heterogeneous nuclear ceramics supporting spent nuclear fuel disposal

Since the 1960s the use of mixed Pu-/U-oxide ceramic (MOX) increased for nuclear energy production. MOX spent nuclear fuel (SNF) presents strong challgenges for its disposal due to its complexity, high radioactivity and limited research experience. To understand how microstrucutre in MOX ceramics evolves, the development of laboratory-scaled synthesis methods are needed with precise control over key synthesis steps like sintering. Resorting to less radioactive materials like CeO2 allows synthesis in usual laboratory conditions. The present study focuses on how different preparation routes impact the microstructure and associated redox chemistry of Ce- and Pu-doped UO2 as MOX SNF materials. To synthesise Ce-based surrogate MOX, different UO2 precursors were used. The samples were analysed via SEM/EDS/EBSD. These are benchmarked against real MOX. The microscopy results show that the UO2 powder origin has a noticable impact on the final ceramics microstructure in terms of grain size and Ce distribution. Synchrotron HERFD-XANES analysis unveilded, that microstructure affects the ratio of contained Ce4+/Ce3+ and U4+/U5+. This can potentially impact the ceramics dissolution vulnerability, as phases containing Ce3+/U5+ are known to be more prone to dissolution than those with Ce4+/U4+. The results of this investigation will be discussed in relation to the geological disposal of MOX fuel, as well as the challenges involved in generating reliable Ce-based surrogate materials for MOX.

Professional Status of the Speaker

Doctoral or Master Student

Interest in submitting a paper in a special issue of

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Invitation letter for visa

No

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