Fabrication avenues for high-performance UO_2 fuel candidates

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Uranium dioxide is the most commonly used fuel in nuclear power plants for energy production. Within the Advanced Fuels Campaign, we are looking into the fabrication of high-performance UO_2 fuel candidates. The aim of this study was to develop a suitable fabrication avenue to synthesize UO_2 feedstock with controlled dopants to enhance UO_2 grain growth within these fuel candidates. Enlarged UO_2 grains in a nuclear fuel pellet are expected to slow down fission gas diffusion which would be a superior property for a high-performance fuel compared to UO_2. The unique fabrication processes for microspherical feedstock via the internal gelation approach [1] have been further developed to enable the dopant uptake within the UO_2 microspheres. A recent computational study by Cooper et al. [2] proposed Mn to have a highly beneficial influence on UO_2 grain growth. Therefore, we added Mn and Cr via infiltration and/or addition of the dopant to the starting broth of an internal gelation experiment [3]. The dopants were added in various amounts in the parts per million range into UO_2. Even though, large amounts of these dopants volatized during sintering, scanning electron microscopy images of the microstructure revealed large UO_2 grains of up to 80 μm for the pellets prepared from doped microspherical feedstocks.

Future irradiation studies within the MiniFuel project at the Oak Ridge National Laboratory will enable post irradiation examination studies to evaluate the in-reactor performamnce of these potential enhanced fuel candidates.

[1] Hunt *et al*. (2019*) J. Nucl. Mater*. **515**, 107-110. [2] Cooper *et al*. (2018) *Acta Mat*. **150**, 403-413. [3] Finkeldei *et al*. (2019) ORNL/SPR-2019/1067.