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Low-temperature oxidative sintering of nano-sized $(U,Pu)O_2$: Effects on densification and microstructural homogeneity

Previous investigations demonstrated that micro-sized (U,Pu)O2 (MOX) powders sintered at 1200 ℃ in a mildly oxidative CO/CO2 atmosphere achieve high density and stoichiometry, yet exhibit limited homogeneity and coarse grain structures compared to conventional sintering at 1700 ℃ in a reducing H2/H2O environment. Conversely, nano-sized MOX sintered under reducing conditions at 1700 ℃ reaches comparable density while exhibiting enhanced microstructural uniformity and finer grains. This work evaluates a hybrid approach: combining low-temperature oxidative sintering with the intrinsic diffusional advantages of nano-MOX. We test whether sintering nano-MOX at 1200 ℃ in CO/CO2 can reproduce the high density and homogeneity normally reserved for high-temperature reducing conditions.
Using established micro-MOX parameters as a reference, nano-sized MOX pellets were sintered at 1200 ℃ for 2 h (CO:CO2 = 1:9) to determine if enhanced surface energy and shortened diffusion distances improve the low-temperature oxidative sintering process. Post-sintering characterization included geometrical density measurements, scanning electron microscopy, and X-ray diffraction (XRD) to assess grain size, phase purity, and compositional uniformity. The XRD analysis confirmed the formation of a single-phase solid solution. Here, we discuss the distinct impacts of starting powder morphology on the resulting microstructure and the evolution of the solid solution under oxidative sintering conditions.

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No

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