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Abstract Numat 2022

Title : Peroxide co-conversion as an original route for mixed (U,Pu)O₂ pellet fabrication.

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MOx pellets (UO₂-PuO₂) with high PuO₂ content (above 15 wt.% Pu) are regarded as promising nuclear fuel for Sodium cooled Fast nuclear Reactor. Standard pellet fabrication is based on powder metallurgy processes (grinding, pressing and sintering) using typical UO₂ and PuO₂ powders. The object of the present study is to examine, at the laboratory scale, an alternative route based on powder co-precipitation in peroxo-nitric media.

The precipitated solids were found to be composed of uranyl peroxide (studtite) and Pu(IV) peroxo-nitrate. The ratio between these two compounds fully followed the actinide ions ratio of the feed solution. The oxide conversion, carried out under reducing conditions, yields fine powder with high specific area. As expected, the obtained oxide powder granulometry appears to be mainly bimodal, namely at 650nm and 7µm, and with some 55µm-sized coarse particles resulting from physical aggregation. The green pellet, obtained by uniaxial pressing of the raw powder, was sintered at 1700°C for 4 hours in Ar + H₂ (5%) + 200 ppm H₂O with a heating ramp of 2°C.min⁻¹. The constant water concentration in the furnace was ensured by monitoring the oxygen partial pressure during all the sintering cycles.

The obtained pellet exhibits a relative density equal to 95 ± 1 %. The porosity of 5 % was confirmed by optical image analysis performed on pellet polished cross-section, showing 1mm long cracks throughout the pellet oriented in a perpendicular fashion of the pressing direction. The grain size distribution appears monomodal centered at about 8 µm (Equivalent Circular Diameter). EPMA analyses confirm the homogenous actinide distribution. More surprisingly, XRD and µ-Raman analyses indicate the formation of a single phase (U,Pu)O₂ solid-solution with a fluorite structure and low defect concentration. The presentation will focus on the structural and microstructural characterizations of the sintered pellet.