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Study of alpha self-irradiation on americium-doped uranium oxide

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The transmutation of minor actinides in the future generation of fast-neutron nuclear reactors is an option to decrease the volume and the overall radiotoxicity of the nuclear fuel inventory. Within minor actinides, americium is the one having the highest radiotoxicity. Several scenarios are considered for introducing it back into the core of nuclear reactors, either homogenously distributed in the nuclear fuel, or heterogeneously loaded in minor-actinide bearing radial blankets.

Due to its high alpha activity, americium strongly increases the alpha dose received by the fuel over time. For this reason, many studies focused on the effect of alpha self-irradiation in americium bearing materials. Here, we present results obtained on UO2 samples doped with 241Am at 5 at.% level. The samples were prepared by a sol-gel co-precipitation method ensuring a homogeneous starting material. The work mainly focuses on the effect of alpha self-irradiation on the low-temperature specific heat, which in pure UO2 is characterised by a large anomaly at 30.8 K signalling a first-order magnetic transition. While self-irradiation damage accumulates with time, the anomaly shifts to lower temperature and broadens as the phase transition becomes discontinuous. The study is complemented by a characterization of the time evolution of the material microstructure through powder X-ray diffraction, transmission electron microscopy, and Raman spectroscopy.

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