RERTR 2017 - 38th International Meeting on
Reduced Enrichment for Research and Test Reactors

November 12-15, 2017
Embassy Suites Chicago Downtown Magnificent Mile Hotel
Chicago, IL USA

Pore pressure estimation in irradiated UMo

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ABSTRACT

During recrystallization, the original UMo grains get refined and the fission gas nanobubble lattice, formed at low fission densities, collapses, thus leading to the appearance of µm-sized pores and the growing up of fuel porosity. Scanning electron microscopy images of U7wt.%Mo SELENIUM and SELENIUM 1a fuel plates have been analyzed using image analysis tools and stereology principles. The kinetics of recrystallization and the pore size distributions were thus discerned. The fraction of recrystallized fuel and porosity evolve congruently among the analyzed fission densities, independently from the irradiation history. The reconstructed 3D pore size distributions have been used as inputs of a model to estimate the pore pressure. The applied model relies on the inference of the amount of fission gases filling the pores through a combined use of gamma scanning and electron probe micro-analysis (EPMA). The Ronchi's correlation has been chosen as governing equation of state in dictating the pore pressure. The pores resulted to be in equilibrium with the host material at the beginning of recrystallization, while they are getting overpressurized with its proceeding, finally reaching pressures high enough to suggest a relaxation through punching dislocation loops. The evolution of the pressure inside the µm-sized pores has been discussed considering the progressive build-up of fission gases in the pores and an irradiation-induced evolution of the mechanical properties of the fuel. The obtained results point out the need of further characterization of UMo fuel from a mechanical and microstructural point of view.