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State of chromium in chromia doped uranium dioxide fuels

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Large grain uranium dioxide fuels, doped with different transition metal oxides as additives, are being used in light water reactors worldwide for energy production. Most of the doped UO2 have been produced in order to improve the fuel performance as compared to the standard UO2 ones. In this context, chromia (Cr2O3) has been used to fabricate successfully larger than standard UO2 grain structures. Therefore, it is of paramount importance to understand the role of chromium as a dopant in UO2 matrix and any apparent change of its state that may occur in chromia doped fuels as a result of irradiation effects. In this work the next neighbour atomic environment of chromium in Cr2O3-doped uranium dioxide has been investigated using advanced x-ray techniques, such as micro X-ray absorption fine structure (micro-XAFS) spectroscopy and micro X-ray fluorescence (micro-XRF). Characterization tests were performed at the micro-XAS beamline, SLS, Paul Scherrer Institute (PSI). The investigated fresh material was pure UO2 powder enriched up to 4.8% and sintered with 1600 ppm Cr2O3. Spent doped-fuel pellet was previously irradiated in two cycles in a commercial reactor with an average burn-up of about 40 MWdkg-1. The Cr K-edge XAFS spectra using micro-focused synchrotron light were measured for both fresh as well as irradiated UO2. Collected spectra were analyzed and quantified using the FEFF 8.40 code. To fit the theoretical spectra with experimental data, two types of different clusters were considered. In the first model substitution of U by Cr in UO2 has been done. In the second model molecular clusters of UCr2O6 have been considered. Thereafter, chromium next neighbor's distances and other structural properties were determined. The results of the difference in chromium speciation between fresh and irradiated UO2 were discussed based on the comparison of quantitative structural parameters obtained from the investigated chromia-doped two fuel samples.

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