Understanding the dissolution of Advanced doped nuclear fuels for geological disposal

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The addition of dopants, including chromium and aluminium, to uranium dioxide fuel results in the formation of larger grained microstructures, capable of higher fission gas retention and reduced swelling during operation within nuclear reactors. Despite their growing use by nuclear power plant operators, the long-term dissolution behaviour of spent doped fuels, when compared to typical spent fuel, is not yet well constrained. In a geological disposal facility, the release of radionuclides is known to be controlled by the oxidation of the UO_2 matrix and the subsequent dissolution of UO_2^{2+} species, therefore any changes to the matrix from the addition of dopants could be expected to influence the dissolution kinetics and / or mechanisms.

We here present the results of an investigation of how the addition of Cr_2O_3 to UO_2 fuel influences the crystal chemistry of UO_2 and its dissolution kinetics. Initial results, from experiments performed in air and a bicarbonate solution, show that addition of Cr_2O_3 reduces the normalised mass loss of uranium (Fig. 1). The potential influencing factors that give rise to increased durability with Cr addition, e.g. defect concentration, Cr-oxidation state etc. are discussed.

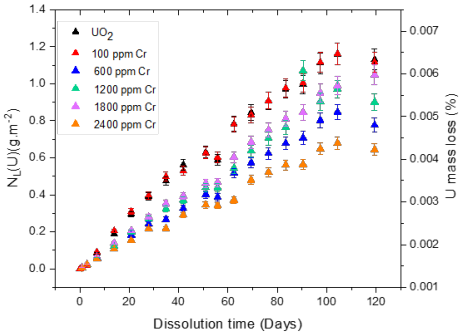

Figure 1. Normalised U mass loss ($g.m^{-2}$) from Cr_2O_3-doped UO_2 over a 120-day period of dissolution in 19mM NaCl + 1mM $NaHCO_3$ at 25 °C, as a function of Cr_2O_3 content.