Lumps, bumps and pyrophoric powders - nuclear waste viewed in a new light.

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How do you look inside a nuclear waste package without breaking it open? This question is important when the contained corrosion products are potentially flammable and radioactive. Synchrotron X-rays have been used to perform micro-scale *in situ* observation and characterisation of uranium entrapped in grout; a simulation for some intermediate level waste. Using specially designed analysis cells X-ray tomography and x-ray diffraction have been used to generate both qualitative and quantitative data from a grout encapsulated uranium sample before, and after, deliberately constrained H_2 corrosion. Tomographic reconstructions determined the extent, rates and mechanisms of the oxidation reaction by assessing the relative densities between the materials and the volume of corrosion products. The oxidation of uranium in grout was shown to follow the anoxic U + H_2O oxidation regime, and the pore network within the grout was observed to influence the induction period for the initiation of uranium hydride formation across the surface of the metal. Powder diffraction analysis identified the corrosion products UO_2 and UH_3, and permitted measurement of corrosion induced stress. Together, x-ray tomography and diffraction provide a means of accurately determining the types and degree of uranium corrosion occurring, thereby offering a future means for studying the reactions occurring in real full-scale waste package systems.

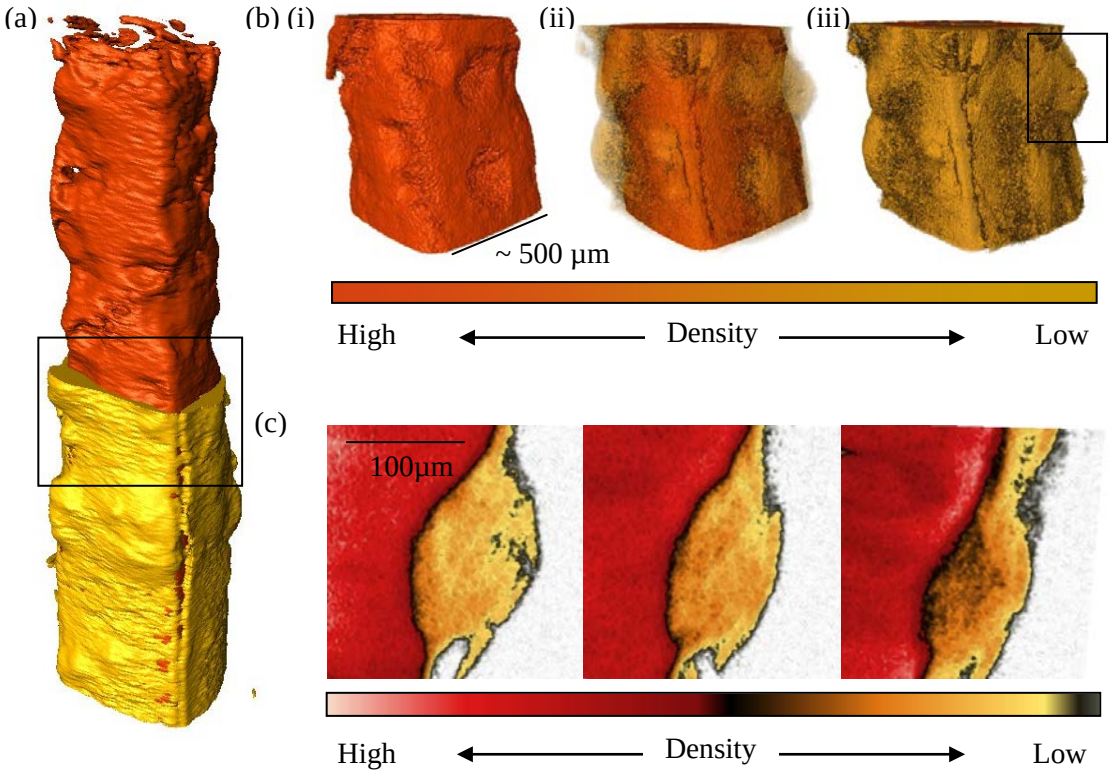

Fig. 1. 3D reconstructions of the H_2 corroded uranium encapsulated in grout. (a) The entirety of the uranium rod examined showing both the inner original uranium (orange) and a mixture of UO_2 and UH_3 in yellow. The box drawn on (a) corresponds to the area examined in (b). Images (b) and (c) are relative density maps of the uranium and corrosion products in aspect and cross section respectively. In (c), black was used to aid distinction between corrosion products, uranium and grout and the area corresponds to the box drawn on (biii).