diamond

Nuclear

CASE STUDY

Nano-scale processes in radwaste management

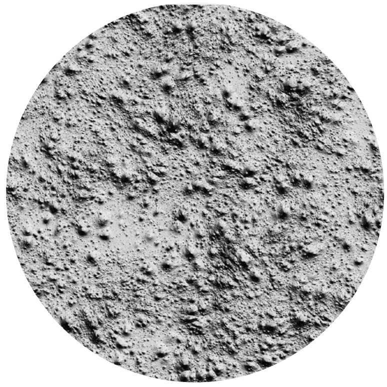
Management and disposal of higher activity radioactive wastes is a significant issue across the developed world as many countries with a history of nuclear power generation and military activities seek long term solutions for these materials.

The most common disposal choice is containment within a deep geological disposal facility (GDF). To remain effective over the long term, the design of a GDF must limit the mobility and migration of radionuclides.

MANCHESTER 1824

The University of Manchester

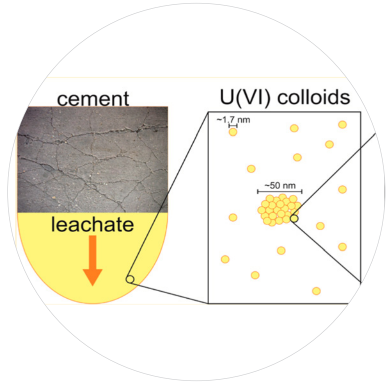
The Challenge



The interaction of radionuclides with geological materials is key to understanding the mechanisms by which radionuclides can become mobile.

Most designs for GDF involve extensive use of cement to seal the wastes as well as engineer and backfill the site ready for closure. Over time, groundwater will interact with the cement to form a plume of hyperalkaline leachate. While high pH can prevent solubilisation of uranium, a key radionuclide in wastes, by sorption / precipitation of hydroxide phases these extreme conditions may lead to the formation of U(VI) colloids which could, in contrast, enhance the mobility of U.

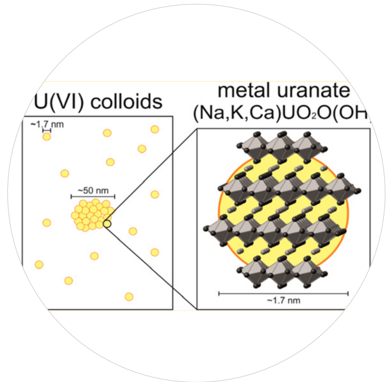
The Solution



A team from The University of Manchester worked with Diamond scientists to apply both in situ and *ex situ* X-ray techniques to characterise the formation of U(VI) colloids in synthetic cement leachate systems. Small angle X-ray Scattering (SAXS) was used to characterise U systems. Nano-particulate U-colloid formation was observed occurring within hours and by measuring aged samples, the colloids were stable for several years under some conditions.

X-ray absorption spectroscopy (XAS) showed that the U-colloids had a sodium uranate-type crystallographic structure.

The Benefits



Understanding the potential for U-colloid formation at high pH is important in understanding U-behaviour in deep geological disposal. This current work highlights the potential importance of U-colloids and further work is ongoing to understand their interactions with cements. More broadly, these techniques are being applied to understand colloid behaviour in radionuclide impacted environments and systems: current work includes studies looking at iron oxide floc formation in a radioactive effluent treatment system.

"We are really beginning to access a full range of synchrotron techniques at Diamond using radioactive samples by working closely with the team on site. This is allowing us to make real progress in understanding radionuclide and colloid behaviour in really important radioactive treatment and waste disposal systems. This information will be used to underpin management, decommissioning and ultimately disposal of these radioactive materials and we are keen to develop further work with industry in these areas." **Prof Katherine Morris, University of Manchester**

For further information

Diamond Industrial Liaison Team

+44 1235 778797
industry@diamond.ac.uk
diamond.ac.uk/industry
@DiamondILO