Improving nuclear efficiency and safety through fundamental chemistry

Safe storage of nuclear waste requires a detailed knowledge of its chemistry. Professor Steve Faulkner's research is helping to build a safer and more efficient nuclear future by studying the reactivity and mobility of nuclear waste.

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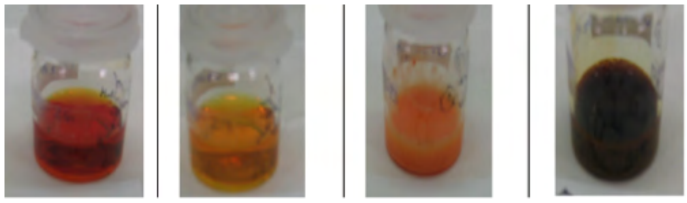
Understanding the chemistry of elements involved in the nuclear fuel cycle is crucial for ensuring the safe storage of nuclear waste, and for improving the reprocessing of used nuclear fuel, which allows Uranium to used more efficiently and reduces the volume of waste that needs long-term storage.



pH dependent variations in speciation of uranyl hydroxamates

Professor Steve Faulkner and his group work on the fundamental chemistry of the Lanthanide and Actinide elements, especially Uranium and Plutonium. The properties of these elements govern their mobility in water and the processes involved in separating different components of used fuel.

The reactivity and mobility of nuclear waste are of upmost concern when considering safe storage. Understanding which waste species are mobile in groundwater is crucial for preventing potentially dangerous leakage and contamination. Work by Prof. Faulkner's group on establishing the nature of mobile waste species and establishing how apparently immobilized ions can be converted into species that travel through groundwater is integral to this. Research on the spectra and photophysical properties of the Actinides is improving understanding of the form and oxidation state of the mobile species.

Small leakages of radioactive material into the natural environment can have large consequences over time. Developing a reliable method to detect very small amounts of fuel-cycle material is vital both for the safety of nuclear power plants and for nuclear waste disposal. Oxford Chemists are helping the National Nuclear Laboratory to improve the ability to detect very small quantities of materials by developing molecules that bind Actinides and, in the process, become luminescent when exposed to ultra-violet light. In the case of neptunium, environmental detection can be achieved at concentrations up to seven orders of magnitude lower than observable by current radiometric methods

There are concerns that there might be a shortage of cheaply available Uranium within a couple of generations if use of nuclear energy expands rapidly. Reprocessing used nuclear fuel to extract fissile Plutonium and Uranium, which can then be re-cycled as fuel, allows Uranium to be used more efficiently, and can radically reduce the volume of waste that needs long-term storage. Twice-through fuel cycles can improve the efficiency by some 20%. Fast breeder reactors use fuel some 60 times more efficiently than conventional reactors, and can burn long-lived waste. Separating Uranium from the minor Actinides is not straightforward, in particular because Neptunium and Uranium have very similar properties. Research in Oxford on the chemical composition of nuclear fuel and the waste streams is helping to make reprocessing more efficient.

By understanding the chemistry of the nuclear fission fuel-cycle elements and their interaction with the environment, Oxford chemists are helping to build a safe and more efficient nuclear future.

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