**EPSRC DLA PhD Studentships**

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**Section 2 – *Project Information***

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| **Project Title** | New chemical tools for actinide-lanthanide separation |
| **Project Summary**  |
| **Background.** The UK Government has set out several ambitious targets for increasing renewable energy production and decarbonising the energy sector, as part of the *Clear Energy Superpower* mission. In this context, nuclear energy will play a pivotal role, with important nuclear projects that need to be delivered (Hinkley Point C, Sizewell C) and new technology that could revolutionise the energy sector (e.g. small reactors). Spent nuclear fuels are an important component of the lifecycle of any nuclear programme. Reprocessing methods are vital for repurposing nuclear waste and for making their disposal and long-term storage safer, thus reducing the potential environmental impact of nuclear waste. Separation techniques are essential for this purpose, as their implementation can be used to: 1) extract valuable materials (uranium, plutonium and other actinides); 2) reduce the long-term radioactivity and volume of nuclear waste.**Project Aims.** This project will focus on designing/testing more efficient separation strategies important for the nuclear fuel cycle. The primary focus will be on using selected lanthanide surrogates that can mimic chemical behaviour of uranium and trans-uranic elements. A second part of the project will extend to testing these systems with uranium sources, in order to investigate the formation of model uranyl-containing compounds (typical in nuclear waste streams) and study their physicochemical properties. To achieve this, we will implement ligand design to fine tune the properties (e.g. solubility, crystallinity, redox behaviour) of resulting metal complexes, which are key components for efficient separation strategies. The final part of the project will bring together lanthanide and actinide work, using the differences in physicochemical properties of model complexes to devise separation strategies, working on surrogate mixtures that mimic high-level nuclear waste streams. The successful candidate will develop extensive knowledge of ligand design and its application in coordination chemistry, together with a deep understanding of key aspects of nuclear chemistry (e.g. fuel reprocessing, decommissioning, remediation).**Methodology.** All compounds will be synthesised using *state-of-the-art* anaerobic methods (e.g. glovebox, Schlenk line) and a suite of characterisation techniques (multinuclear NMR, X-ray diffraction, UV-vis-NIR spectroscopy, photoluminescence, electrochemistry). Additionally, this work will be complemented by comprehensive magnetic studies (EPR and SQUID) whenever appropriate, in collaboration with the EPSRC EPR National Research Facility (University of Manchester). Active work with depleted uranium will be carried out in the facility at Space Park Leicester, and also with external collaborators. In conjunction with standard synthetic work, the successful candidate will also perform reactions with small molecules and kinetic studies. |
| **References** |
| 1. B. Hong *et al.*, *Inorg. Chem.*, **2024**, *63*, 17488–17501
2. S. Wu *et al.*, *Phys. Chem. Chem. Phys.*, **2024**, *26*, 2205–2217
3. T. Vitova *et al.*, *Communications Chemistry*, **2022**, *5*, 12
4. F. Ortu *et al.*, *J. Am. Chem. Soc.*, **2021**, *143*, 13184
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