A fundamental understanding of uranium hydride formation

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The uranium-hydrogen reaction is one that has been studied in great detail across the nuclear sector. It features heavily in discussions about nuclear waste storage; as a potentially pyrophoric, powdered biproduct from the corrosion of stored waste uranium metal. It also has an unwanted presence in the storage of sensitive nuclear materials. This proclivity, for metallic uranium to readily react with hydrogen, and the kinetics of this process, make it ideal for the storage of hydrogen, and it is, in fact, the current method of choice for the storage of tritium for use in fusion reactors. There are, therefore, real vested interests in fully understanding the mechanism of this reaction and the behaviour of the uranium hydride material.

Uranium hydride is not just important from an industrial perspective, but has some intriguing solid-state properties, driven by the often-strange behaviour of the actinide 5f electronic states. The proposed PhD project will synthesise uranium hydride in a number of environments (from oxidation of metal films and powders to hydriding under pressure in diamond anvil cells etc.). The student will utilise the radioactive handling and preparation laboratories and dedicated actinide deposition system, unique in the UK (and now part of the National Nuclear User Facilities).

Characterisation will be conducted using a range of surface analysis techniques, with particular emphasis on utilising x-ray diffraction (XRD) and x-ray photoelectron spectroscopy (XPS). We will make use of the high pressure/low temperature capabilities of the correlated electron systems group and the Bristol Oxford Nuclear Research Centre (NRC), employing the Oxford TEM suite to investigate the hydride structures on an atomic scale.

The student will need to design and implement creative experimental designs (in collaboration with PDRAs and academics in the team). There will be scope within the project to propose and carry out large scale facility experiments at synchrotron/neutron sources nationally and internationally. This is a very rare opportunity to work on some very challenging and interesting materials.

This PhD will be linked to the TRANSCEND consortium on nuclear waste and decommissioning; a £10m EPSRC/industry collaboration, featuring more than 12 UK universities and over 20 students.