Advanced Fuel for Integrating Nuclear SMRs with Renewables

Joint PhD between ANSTO and UNSW, supported by Tyree Foundation

Electricity grids world-wide have an ever-increasing share of variable (non-dispatchable) renewable energy sources. This is helping to reduce the carbon intensity of the electricity sector, but it comes with its own challenges, as the grid operators are faced with the challenge of balancing a variable load (the consumers) with a variable supply (the generators). Load-balancing services are costly, and for the most part not environmentally friendly. However, nuclear small modular reactors (SMRs) provide a promising solution to help stabilize energy grids while also generating additional carbon-free energy.

While nuclear reactors can be, and have been, used to "load follow" the demand of the electricity grid, they have not been optimized for that purpose. Current civil nuclear reactor designs have been optimized for maximal power output, not for fast variation in power output. Since few nuclear reactors have ever been operated in a load-following manner, we have little understanding of the effects of fast and frequent power ramps on the degradation of the fuel. The limited data available suggests that increasing load-following operations results in accelerated chemical corrosion between the nuclear fuel pellet (made of uranium dioxide) and the fuel cladding (made of Zr alloy). This is known as pellet-clad interaction (PCI).

The aim of this project is to establish a mechanistic understanding of fast power ramp rates on PCI and fuel degradation. The findings will inform the development of SMR fuels that are tolerant to the fast power ramp rates required for load-following applications. The project will use a combination of radioactive materials synthesis, advanced characterisation and atomic scale modelling to investigate (1) the effect of power changes to the fission products yield, and (2) the effect of thermal cycling on (a) the structure and chemical composition, and (b) the thermal and physical properties, of the fuel pellet and PCI layer.

This is a joint PhD project between the Australian Nuclear Science and Technology Organisation (ANSTO) and the University of New South Wales (UNSW Sydney), supported by charitable donations from the Tyree Foundation. The candidate will be supervised by Dr Jessica Veliscek Carolan (ANSTO) and Dr Patrick Burr (UNSW), and will work within a tight-knit, inclusive, and enthusiastic group of diverse background. We value diversity and encourage applications from all backgrounds to apply. A background in material science, materials engineering, inorganic chemistry or condensed matter physics is welcome.

This position is open to Australian domestic students, and comes with a Sir William Tyree Nuclear Scholarships of $7,500 stipend top-up. An additional $5,000 of travel support is available for regional students. For further queries and applications email p.burr@unsw.edu.au and jvc@ansto.gov.au. When applying, please include your CV and transcript of most recent or current degree. Expressions of interest close on 31st May, or when a suitable candidate is found, whichever comes first.