Borides for advance fusion and fission

PhD Scholarship

Metal borides are extremely hard materials with some of the highest melting temperatures known to mankind. Their unique properties make them well-suited to a raft of high-end applications in extreme environments, from supersonic flight to cutting tools. This project aims to develop boride materials suitable for the extreme environments found in *nuclear fusion* and *nuclear fission*.

In fusion, metal borides can shield sensitive components, such as superconducting magnets kept at –250 °C, from the high energy radiation produced inside the plasma (which operates at ~ 100 million °C). In nuclear fission, borides can be used as a *burnable absorber*, which extend the life of nuclear fuel inside the reactors, thereby reducing the resources used, the waste produced, and the cost of electricity from carbon-free nuclear energy. They are also promising candidate material for accident tolerant fuels, i.e. nuclear fuel that is capable of surviving sever accident conditions.

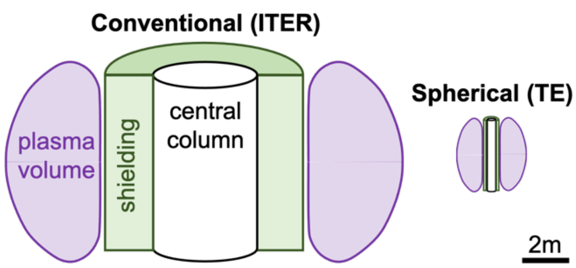

Figure 1 – Size comparison of conventional tokamak reactors (e.g. ITER) and spherical tokamak reactors (e.g. Tokamak Energy). The central column (in white) houses superconducting magnets stored at –250 °C, while the fusion plasma (purple) operates at over 100 million °C. The shielding (green) must provide protection from both extreme heat and high-energy radiation.

While these borides have exceptional thermo-mechanical properties, their response to the extreme environment of a fusion or fission reactor is yet unknown. The aim of this project is to develop an understanding of the radiation damage in these advanced materials when exposed to neutron radiation, and the effect that these will have on the materials properties.

Two candidates are sought: one student for synthesis and characterization using a suite of advanced techniques, including microscopy, spectroscopy, neutron and synchrotron diffraction. The other will perform atomic-scale modeling, including molecular dynamics, object kinetic Monte Carlo and by developing inter-atomic potentials (possibly using machine learning techniques).

The project is supported by a generous scholarships of $38,600/year stipend plus up to $10,000 of travel support. Candidates with an exceptional track record may be eligible for additional scholarship top-ups. The candidate will be based at UNSW Sydney, in the AtomCraft research group led by Dr. Patrick Burr. We are a tight-knit, inclusive, and enthusiastic group of diverse background. We value diversity and encourage applications from all backgrounds to apply.

For further queries and applications email p.burr@unsw.edu.au. When applying, please include your CV and transcript of most recent degree (or interim transcript if degree is not yet completed).

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