# Modelling nuclear materials with discrete element methods

## PhD scholarship

Next generation advanced nuclear reactors are an attractive proposition for carbon-free energy generation, and are expected to play an important role in the global effort to decarbonize society. They offer many advantages over current nuclear reactors, including recycling of spent fuel, reduced waste generation, increased thermal efficiency, increased proliferation resistance and production of heat for industrial processing and hydrogen production. However, advanced reactors also operate under more severe conditions, and require materials capable of withstanding extreme environments.

Graphite, carbon-carbon and SiC-SiC composites are some of the most promising candidate materials for structural and moderator components of certain advanced nuclear reactor designs. While their thermo-mechanical and neutronic properties are exceptional, their application is limited by the lack of sufficient understanding of their mechanical response, and failure mechanism, under applied load.

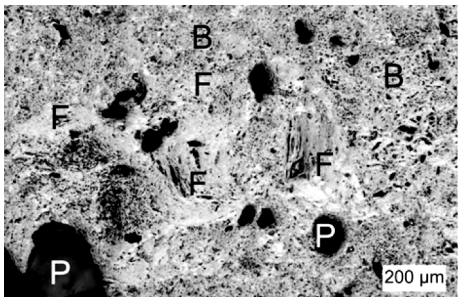


**Figure 1 – Optical micrograph of nuclear graphite, from J. Kane *et al.*, J. Nucl. Mater. 415 (2011) 189. P = pore; B = binder; F = filler.**

Nuclear-grade graphite is an amalgamation of various (rigid) carbon fillers, binders and pores. As such, its mechanical properties are poorly described by continuum mechanics (such as finite element methods), which cannot capture the stochastic nature of the material. Instead, this project will explore the use of discrete element method (DEM), which is commonly employed in geosciences as well as asphalts and concretes. The candidate will first develop a DEM model specifically for materials applications, using nuclear graphite first and extending it to other relevant discontinuous materials (C-C and SiC-SiC composites). The student will perform mechanical tests on nuclear graphite specimen to inform the model, and subsequently to test its validity in more complex loading scenarios.

The candidate will be supervised by Dr. Patrick Burr and Prof. Jay Kruzic, and will be part of the wider nuclear research group (AtomCraft) at UNSW Sydney. We are a tight-knit, inclusive, and enthusiastic group of diverse background. We value diversity and encourage applications from all backgrounds to apply. A background in geomechanics, solid mechanics or materials science is beneficial, as is competence in computer languages and programs.

The project is supported by a generous scholarship of $38,600/year stipend plus $10,000 of travel support, provided by a philanthropic donor. Candidates with an exceptional track record may be eligible for additional scholarship top-ups. Send email applications and queries to p.burr@unsw.edu.au. When applying, please include your CV and transcript of most recent or current degree.