Graphite is used as a moderator – a medium that reduces the speed of neutrons, making them capable of sustaining a nuclear chain reaction. In British Advanced Gas Cooled nuclear reactors, due to its high moderating efficiency, abundance and relative low cost, graphite is used as a moderator.

Methods

British Pile Grade A (PGA) graphite samples were machined to cubes of size 1 cm³. A confocal laser microscope capable of producing high resolution 3D images was used to image the samples during the application of stresses, allowing the surface profile of the material to be studied. Stress was applied axially using a compression rig as shown in the image below.

Conclusions

When PGA graphite is compressed perpendicular to the extrusion direction, damage to the microstructure can be split into two categories – recoverable and non-recoverable damage. Non-recoverable damage was found to occur in the filler particles, predominantly at low loads. At higher loads, the deformation was found to be recoverable and, beyond a specific threshold, almost all sample contraction was found to recover upon removal of load.

The pore area distribution at the surface of the sample was plotted using bin sizes of 2 µm², and frequency was found to be related to pore area by a power law.

Further Work

• The experimental method will be repeated with samples at different orientations, as anisotropic materials respond to stress differently depending on the orientation with respect to the direction that the load is applied.
• Digital image correlation will be performed on pairs of images to determine where the strains are concentrated in the samples. From these strain maps the variation of local Young’s modulus can be investigated.
• X-ray Tomography will be used for three-dimensional imaging of the interior of graphite. Of particular interest is the closed porosity, which cannot be imaged in any other manner.