Plasticity-induced damage in high temperature reactors

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Creep damage is the principal life limiting factor in the life of a thermal plant. In a plant the damage accumulates over decades but to study creep damage root-cause and effects in reasonable timescale, short term experimental testing (creep acceleration) is required. The accelerated creep tests require a detailed understanding of the failure mechanisms to permit extrapolation to lower temperatures and/or stress levels. A major complication occurs as a result of other damage mechanisms such as time independent plasticity occurring during accelerated test which influence the failure of the specimens and load geometry. Decomposition of creep damage from other damage mechanisms (e.g. plasticity) in an accelerated creep test in the main focus of this project.

The project will employ advanced experimental techniques such as digital image correlation, electron backscattered diffraction and synchrotron X-ray diffraction. These will be combined with state-of-the-art modelling, including crystal plasticity finite element analysis. The findings from the project will be directly incorporated into design and assessment methods currently being used on High Temperature Nuclear power plant. Critically, the key results are expected to be included in the integrity assessment procedures the engineers use day to day to evaluate the fitness for service of reactor components. The studentships offer an excellent platform for future career opportunities our alumni have top level jobs at nuclear industry companies.

The work will be carried out in a newly modernised well-equipped high temperature mechanical testing facility at University of Bristol in collaboration with experts at EDF Energy and other researchers in The Solid Mechanics Research Group (SMRG). SMRG is also a regular user of UK major facilities such and Diamond Light Source and ISIS Neutron and Muon Source.

Based in the Department of Mechanical Engineering at University of Bristol (UoB), SMRG focusses on industrially-relevant research in support of low carbon energy sector in the UK. Since 2008 SMRG has had research partnership with EDF Energy, who are responsible for operating the existing fleet of UK nuclear power plants. The research has recently expanded to close collaboration with UK Atomic Energy Agency (UKAEA) at Culham Centre for Fusion Energy. This has broadened the facilities and SMRG's structural integrity activities to include fusion as well as fission. SMRG currently has eight academic staff and approximately 20 students and research staff.