High temperature digital image correlation of small punch test (UKAEA)

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Creep damage is the principal life limiting factor in the life of a thermal plant. Materials behaviour in creep regime is evaluated using uniaxial tests. However, the majority of components experience a multi-axial stress state. Stress multi-axiality can have a significant effect on the rate of initiation and growth of creep cavities. Different tests have been proposed to explore the effects of stress multi-axiality on creep deformation and damage in the past of which, small punch tests are gaining more popularity. While inducing an equi-biaxial stress field, presentative of pressurised components, small punch tests concentrate the deformation and damage on the surface of the specimens. This will allow optical techniques such as high temperature digital image correlation technique to be used to interrogate and evaluate damage and deformation during the tests. This project is aimed at designing, optimising, and eventually exploiting optical techniques for creep study of small punch tests. Recently purchased identical equipment at University of Bristol and UK Atomic Energy Authority which allow uninterrupted observation of high temperature small punch tests will be utilised. It is expected that the work is complemented by standard creep tests in order to establish a correlation between the results of the standard tests with those obtained from small punch tests. If significant progress is made, it is expected that the project will expand to exploiting three dimensional techniques such as X-ray tomography combined with digital volume correlation to allow for volumetric interrogation of deformation and damage in small punch tests.

This project is linked to joint work by UK Atomic Energy Authority and University of Bristol on EERA-JPNM (European Energy Research Aliance Joint Programme on Nuclear Materials) on Miniature Test Specimens. 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 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.