

Title: **Improving design against fatigue**

Supervisors: Dr. Hector Basoalto and Dr. David Gonzalez

Project Description:

Fatigue life prediction in the aerospace components relies on fracture mechanics for relatively long cracks ($>1\text{mm}$). Nevertheless, most of the fatigue life is spent while the crack is relatively short ($<1\text{mm}$). However life of short cracks is far from well understood leading engineers to apply over conservative safety factors which involves environmental and economic losses. The material 3D microstructure is responsible for the large life uncertainty in short cracks. Recent experimental techniques, such as high-resolution X-Ray diffraction combined with tomography, have opened up exciting opportunities to in-situ fully characterize the 3D microstructure (grain shapes and orientations). The techniques also allow monitoring the deformation and crack propagation in-situ and in 3D. Imaged-based models can be built from the reconstructed microstructure to provide a unique opportunity to improve crystal plasticity models for fatigue initiation.

The student will build image-based crystal plasticity models from data obtained by diffraction combined with tomography obtained at the European Synchrotron Radiation Facility (ESRF). This would allow validation of the finite element models implemented in ABAQUS software. The student will use and further develop user material subroutines (UMAT) to model the crystal plasticity, user element subroutines (UEL) and post-processing tools. The aim is to improve our understanding on the microstructure-mechanical properties relationships and how short fatigue cracks initiate and propagate.

Applicant and funding:

We are looking for a self-motivated individual with skills and/or interest in solid mechanics, physics, mathematics, materials and computer programming (Fortran, Python etc). Knowledge in finite element modelling would be an advantage but is not essential.

Due to funding restrictions this position is only available for UK or European Union candidates. Funding covers tuition fees and tax-free annual maintenance payments of at least the UK Research Council minimum (currently £14,777) plus a top-up of £3,500 per annum for 3 years. The position is available to start as soon as possible, preferably no later than September 2019.

Informal enquiries can be made to Dr. Gonzalez (D.GonzalezRodriguez@bham.ac.uk) or to Dr. Basoalto (H.Basoalto@bham.ac.uk)

About PRISM2 research group:

PRISM2 at University of Birmingham is led by Dr. Hector Basoalto and consists of around 20 members between research fellows and PhD students working on a range of modelling projects. The group focuses on the simulation of the mechanical behaviour of materials at different length scales. In the recent years, PRISM2 group has been successful in securing funding from EPSRC, EU, IUK and industrial partners in excess of £8M. The group works very closely with industrial partners such as Rolls-Royce, TIMET and MTC, as well as partners in the nuclear sector including EDF Energy, AREVA NP, EPRI and AB Sandvik. More information about the group can be found at <https://www.prism2.org/>