Critical Experiments for Predicting Fatigue Crack Growth Behaviour in PWR Components: plasticity

Institution: Imperial College London, Department of Mechanical Engineering

Supervisor(s): Dr Catrin Davies (ICL), Dr Mark Wenman (ICL), Prof David Dean (EDF Energy), Dr Marc Chevalier (EDF Energy)

Sponsor(s): EPSRC and EdF Energy

Fatigue is one of the key degradation mechanisms affecting the integrity of important PWR components. However, metallic fatigue is also a challenge scientific phenomenon that crosses the boundaries of mechanics and materials science. There is a need to conduct critical experiments to gain insight into the microstructural mechanisms at play and assess the influence of different microstructures and environments on the service life of high integrity PWR components.

The goal of this PhD project is to conduct mechanical and materials characterisation experiments to shed light into fatigue crack nucleation and growth, including the role of the environment. This includes mechanical testing and also high-resolution characterisation techniques such as EBSD, EDX, and DIC, which will be used to characterize the microstructure, chemistry and stored distortion in crystals, e.g. grain orientation, dislocation density and residual stresses distribution. The student is expected to collaborate closely with a companion computational PhD project.

The project will be conducted in close collaboration with EDF Energy, who own and operate the only operating nuclear power plants in the UK. This includes the Sizewell B Pressurised Water Reactor (PWR), which is looking to seek lifetime extension, from 2035 to at least 2055. EDF are also constructing EPRs at Hinkley Point C and potentially Sizewell C. In the UK PWR based Small Modular Reactors (SMRs) are also being considered. All of this is a crucial contribution to the UKs ambition of achieving net-zero carbon emissions by 2050.