LMS Seminar

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Micro-mechanical modelling of fatigue in aluminium alloys and their weld joints

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ABSTRACT

The high-strength aluminium alloys are most commonly used for structural and marine applications. They are lighter than many other materials, which means lower power requirements, exhibit good corrosion resistance, and generally require low maintenance. Most of their components and weld joints are exposed to cyclic loadings, potentially leading to catastrophic failure. The research activity in this engineering field is however very limited, but the sector has shown significant growth in the last few years and great potential for future applications. It is thus essential to understand their fatigue properties and to predict them using advanced computation tools. A crystal plasticity finite element (CPFE) simulation framework has been developed in our laboratory to predict the detrimental effect of mean stress and defects (like pores) on the fatigue behaviour of aluminium alloys and their weld joints, specifically AA-5xxx. Several 2D representative models for the material's microstructure, with or without pores, were prepared using an anisotropic tessellation algorithm and the EBSD data. Cyclic loadings at different stress amplitudes were simulated, using the developed models, to generate stress-strain loops and adjust the parameters of constitutive equations by reproducing the measured loops. A crack initiation criterion was applied, as a post-treatment. The experimentally observed scatter in fatigue lives can be very well captured using these simulations. Additionally, the heterogeneity in the distribution of local and far-field stresses can be captured with and without defects. Currently, my research is focused on correlating the temperature gradient with microstructural morphology, reinforcing Al-weld joints by copper nanoparticles dispersion using FSP, and simulating their response including the process-induced residual stresses, both numerically and experimentally. All these aspects of fatigue damage in aluminium alloys shall be presented.

BIOGRAPHY

Dr Vidit Gaur is currently an assistant professor in the mechanical department of the Indian Institute of Technology Roorkee, India and working in the domain of fatigue-fracture studies. After obtaining his Master's degree (MAGIS) from UPMC, Paris VI and PhD from LMS, Ecole Polytechnique, he joined the University of Tokyo as a lead researcher in collaboration with UACJ aluminium group ltd. before setting back to India. During his tenure at IIT Roorkee, he developed a full-fledged research laboratory (Fatigue, Fracture, and Advanced Materials Engineering, F2AME) with several reputed national funding and industrial collaborations. Currently, there are 8 PhD students and 2 Master's students working in his lab.