Integrated Experiment and Modelling of Microstructurally-Sensitive Crack Growth

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Abstract

An assessment is presented of modelling methodologies which explicitly address microstructurally-sensitive crack growth paths in bcc polycrystal ferritic steel. A number of microstructurally differing polycrystal samples are subjected to fatigue and crack nucleation and growth, demonstrating transgranular and intergranular crack paths in characterised microstructures. Microstructurally representative extended finite element crystal modelling, coupled cohesive zone modelling, coupled explicit grain boundary modelling, and plasticity are utilised to assess predicted crack paths against the experimental observations. The incorporation of strong and weak boundary zones when coupled with X-FEM was found to provide quantitative prediction of the transition from transgranular to intergranular cracking and to capture accurately the observed crack paths. Crack tip plasticity was found to have limited effect on microstructurally-sensitive crack path.

Keywords: eXtended Finite Element Method (X-FEM), microstructurally sensitive crack growth, intergranular cracking, transgranular cracking, fatigue