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IMAGE BASED CRYSTAL PLASTICITY MODELS FOR DWELL FATIGUE INITIATION IN POLYCRYSTALLINE ALLOYS

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ABSTRACT

A microstructure sensitive criterion for dwell fatigue crack initiation in polycrystalline alloy Ti- S. Ghosh 6242 is proposed in this paper. Local stress peaks due to load shedding from time dependent plastic deformation fields in neighboring grains are held responsible for crack initiation in dwell fatigue. An accurately calibrated and experimentally validated crystal plasticity finite element model is employed for predicting slip system level stresses and strains. Vital microstructural features related to the grain morphology and crystallographic orientations are accounted for in the FE model by construction of microstructures that are statistically equivalent to those observed in OIM scans. The output of the FEM model is used to evaluate the crack initiation condition in the post-processing stage. The functional form of the criterion is motivated from the similarities in the stress fields and crack evolution criteria ahead of a crack tip and dislocation pileup. The criterion is calibrated and validated using experimental data obtained from ultrasonic crack monitoring techniques. It is then used to predict the variation in dwell fatigue lifetime for critical microstructural conditions. The studies are extended to field experiments on β forged Ti-6242. Macroscopic aspects of loading are explored for their effect on dwell fatigue life of Ti-6242.

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