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Abstract

The low cycle fatigue (LCF) response of three austenitic steels has been studied over a range of cold-rolled reductions. The three steels have different plasticity mechanisms during cyclic deformation: one with prominent transformation induced plasticity (TRIP) behavior, one with a moderate TRIP response, and the third alloy deformed only by slip. The LCF life was found to be directly correlated to the tensile ductility, with more ductile materials showing the highest LCF lifetimes. This relationship was found to be a first order effect, indicating that regardless of the plasticity mechanism (slip or TRIP) the overall ductility of the alloy predominantly determines the LCF lifetime. This is consistent with the observations on dislocation density which showed that an increase in dislocation density during LCF correlated to higher LCF lifetimes, while a drop in dislocation density gave comparatively poor LCF behaviour. The TRIP effect was observed to occur at significantly lower applied stress levels during cyclic fatigue compared to monotonic loading. It is suggested that the development of local stress concentrations during cyclic loading allows transformation to martensite even though the global applied stress is below the critical value required for transformation. The results also suggested that a higher volume fraction of austenite to martensite transformation may provide a small benefit to the LCF life relative to that expected from the tensile ductility.

Keywords: TRIP steel; low cycle fatigue; austenite; martensite; dislocation density.

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