**20th European Mechanics of Materials Conference - EMMC20**
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

# Twinning/detwinning and fatigue crack nucleation sites during cyclic deformation of Haynes 244 Ni-based superalloy

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*Paper ID: 158*
*Symposium S9: Fatigue evaluation: modelling and characterisation at different length scales*
*Extended Abstract*

## Abstract

Haynes 244 belongs to a new family of Ni-based superalloys strengthened by body-centered orthorhombic □”’-Ni2(Cr, Mo, W) precipitates that has been developed for applications at intermediate temperatures requiring low thermal expansion. The mechanical response and the deformation mechanisms of Haynes 244 were studied under strain-controlled fully reversed cyclic deformation at ambient temperature by means of interrupted fatigue tests and microstructural analysis techniques based on surface trace analysis, electron backscatter diffraction, high-resolution digital image correlation as well as transmission electron microscopy. It was found that plastic strain was accommodated by twinning and detwinning during cyclic loading without evidence of dislocation slip. During the tensile part of the cycle, twins are nucleated in the grains suitably oriented for twinning. Detwinning occurs during compressive part of the cycle while other twins are nucleated in grains suitably oriented for twinning in compression. Twinning/detwinning occurs during the fatigue life although the number of parallel twins in each grain

increases with the number of cycles. Twin thickness remains small (in the range 100 nm to 500 nm) indicating the presence of energy barriers that hinder twin growth. In addition, fatigue crack nucleation sites were investigated in samples deformed up to 10% of the fatigue life. It was found that most of the fatigue cracks were nucleated at grain boundaries and annealing twin boundaries that did not allow twin transfer, leading to large stress concentrations. In addition, other fatigue cracks emerged from grain or twin boundaries but propagated along the deformation twin boundaries. The mechanisms responsible for this behavior and their implication on the fatigue life were discussed.

**Keywords:**

fatigue Ni-based superalloys Twinning/detwinning Cfrack nucleation Haynes 244