

# UNDERPINNING AND BENCHMARKING MULTI-SCALE MODELS WITH MICRO-SCALE EXPERIMENTS: AN EXPERIMENTALIST'S PERSPECTIVE

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**Focus Material:** Metals

**Focus of the Presentation:** Multi-scale data acquisition, characterization and experiments at different scales

## Abstract

Multi-scale mechanical response models depend on detailed characterization and experimental benchmarks obtained at salient length scales. Traditional methods for model validation fail to capture the underlying microstructural dependence needed to develop physics-based models. In the current study, microtensile samples have been extracted and shaped from polycrystalline Rene 88DT and are being used to elucidate underlying microstructure-property relations. These scale-specific experiments facilitate integration of mechanical response with key microstructural features (grain size, shape, orientation, etc.) of a finite number of grains that are tractable in crystal plasticity modeling. In a parallel study, the effect of local microstructure on fatigue damage has been ascertained by resonance fatigue testing of miniaturized specimens in a novel micro-bending fatigue setup. Insights on how local microstructure (grain size, shape, orientation and neighborhood) influence local plasticity and subsequent crack formation have been collected and shown to involve: slip initiation on  $\{111\}$  planes, micro-crack nucleation in large grains along, but not at, the twin boundaries experiencing high resolved shear stress and elastic incompatibility, and short crack growth along  $\{111\}$  planes in neighboring grains. In both sets of experiments, quantifying the microstructural dependent mechanical response of oligocrystals opens a valuable pathway for model development and validation.