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Strain localization under monotonic loading near annealing twin boundaries

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In Ni-based superalloys, annealing twin boundaries (ATBs) are vulnerable sites for strain localization and subsequent failure during mechanical testing [1-3]. In addition, as reported by Zhang et al. [4], heterogeneous precipitates could further complicate strain localization at ATBs. Although several past works have explored strain localization at ATBs, the effect of precipitates on such intense shear events remains unclear. Thus, the present work explores strain localization, focusing on the ATB microstructures in superalloys.

Preliminary characterization of several superalloys indicates the presence of two categories of ATB microstructures. In the first category are alloys that exhibit preferential γ′ and γ″ precipitation on the ATBs. In this case, heterogeneous nucleation on the ATBs may be influenced by local phase transformations at the boundaries. In the second category are alloys where the precipitates are agnostic to the presence of nearby ATB. The present work investigates how various factors contribute to the well-documented strain localization events in both classes of alloys. For this purpose, we complement results from In-Situ tensile tests with full-field crystal plasticity simulations. Finally, we present strategies to avoid such intense strain localization events near ATBs based on our analyses.

Keywords: Superalloy, 718, Annealing Twin Boundaries, Strain localization, Crystal Plasticity, Characterization

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