Evolution of texture and dislocation populations during continuous bending under tension (CBT) processing of titanium

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Abstract

Continuous bending under tension (CBT) has been shown to increase the room-temperature elongation-to-failure (ETF) in various materials. However, microstructural mechanisms behind the improvements are still not well understood. Of particular interest are hexagonal closed-packed (HCP) materials, which generally have lower ductility than metals with cubic structures. This work focuses on evolution of texture (including twins) and dislocation populations in commercially pure titanium, intended for aerospace structures. High resolution EBSD characterization of geometrically necessary dislocation (GND) structures, together with XRD-based evaluations of total dislocation density, are combined to arrive at a detailed picture of dislocation behavior. Digital image correlation strain maps of the sheet material, in two planes, i.e., normal to the sheet and through thickness, are obtained during CBT processing for comparison with standard and strain-gradient crystal plasticity finite element models. The combined experimental and simulation campaign illuminates the interrelations between slip system activity, associated hardening rates, strain gradients / backstress, and texture / twin evolution in the sheet during the complex combination of reverse bending and tension across the sheet.

Keywords: EBSD, HREBSD, Dislocations, CPFEA

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