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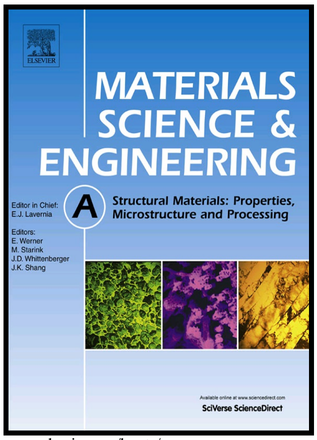

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Hierarchical Evolution and Thermal Stability of Microstructure with Deformation Twins in 316 Stainless Steel

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Abstract

We report extensive nano-twin formation in 316 stainless steel (SS) and the evolution of a hierarchical microstructure through the formation of multi-scale twin bundles after uniaxial tension with uniform elongation levels of 20%, 30%, and 40%. Multiscale characterization techniques were employed to reveal the nature of these twins. The twin density increases with the increasing strain level, however, the twin width remains the same, notably reducing the mean free path of dislocations. Concurrently, significant work hardening is observed during subsequent deformation. The deformation-induced nano-twins are thermally stable up to ~800 ºC, shown by both interrupted and in-situ transmission electron microscopy experiments, above which the recrystallization takes place in the vicinity of the twins. Such favorable thermal stability of the twins in nano-twin strengthened 316 SS offers a promising approach for microstructurally engineering these materials for potential applications at elevated temperatures. The related strengthening mechanisms are discussed in the light of the mean free path of dislocations and the dislocation interactions with twin boundaries.

Keywords: Deformation twinning; 316 stainless steel; Thermal stability; Recrystallization; Strengthening.

1. Introduction

In order to improve efficiency of current power plants and decrease their CO_2 emission, new structural materials are needed that can perform reliably at higher temperatures. These materials

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