Adiabatic shear bands formation in pure titanium

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Abstract

This work addresses the microstructural and textural aspects of shear localisation in α-titanium. A hammering deformation technique, which provides high strain rate deformation has been employed to deform hat-shape specimens. To investigate the effect of initial texture on the microstructure development during high strain rate deformation, hat-shape samples were prepared with different directions relative to prior extrusion direction, i.e. axes along extrusion direction (ED), 45◦ and 90◦ to ED. The textural characterisation was conducted using SEM equipped with an EBSD facility, which is discussed concerning the optical and TEM observations.

High-speed deformation along the ED resulted in the smallest crack length compared with results of loading along other directions, while deformation along 45◦ to ED introduced the longest crack. Different twin types were activated to preserve material continuity and accommodate the strain in the area just outside the band. Regardless of the loading direction, the preferred texture inside the shear bands includes basal planes lying parallel to the shear band plane, while the direction is parallel to the shear band direction.

It was found that strain-induced crystal lattice rotation inside SBs led to the formation of new texture components, different from those identified in the less-deformed matrix. They facilitate slip propagation across the grain boundaries. The macroscopically observed macro-SB plane consists of small segments limited to the particular grains or their fragments. These segments were only slightly deviated from the macroscopic shear plane. The broadest of the shear band was developed during deformation along ED, which is connected to the less capability of material in this case to deform while keeping an acceptable strain homogeneity. Deformation along TD and 45◦ to ED could not successfully introduce new recrystallized grains inside the band, which may be justified according to less strain localization.

Keywords: adiabatic shear band, α, titanium, anisotropy, texture, microstructure

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