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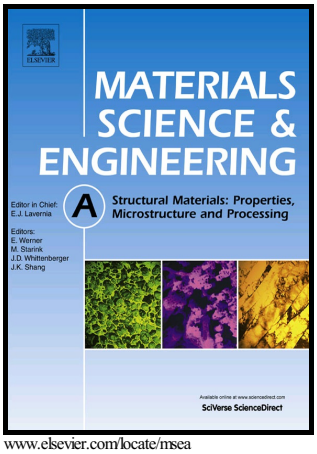

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Strain path dependence of microstructure and annealing behavior in high purity tantalum

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Abstract

Unidirectional rolled (UR) and clock rolled (CR) high purity tantalum sheets were analyzed with an emphasis on the microstructural difference in surface layers. Misorientation characteristics of deformed grains with different orientations are analyzed in detail by visualizing the misorientation angle based on an electron backscatter diffraction dataset. {100}(<100>// normal direction (ND)) grains were found to associate with long-range cumulative orientation changes in CR sample while {111} (<111>// ND) grains were found to contain many micro-shear bands and microbands in UR sample. Then, micro-shear bands and micro-bands were detailedly characterized by transmission electron microscope, and the analysis based on Schmid factor suggested that the primary slip system activated in {111} grains leads to the formation of micro-bands during UR process. Band contrast values were used to evaluate the energy stored in {100} and {111} grains and results showed that the gap of energy between them was narrowed by CR process. Additionally, significant dispersion degree of hardness values indicates the inhomogeneous deformation in UR sample, while different degree in annealed stage indicates the different recrystallization kinetic for UR and CR samples. Upon annealing, nucleation prefers to occur along {111} deformed matrices or {111}-{100} boundaries in UR sample and recrystallization grains are large in size. While nucleation tend to take place in intersected regions in CR sample and recrystallization grains are small, which contributes to the appearance of fine grains in fully recrystallized CR sample.

Keywords: clock rolling; strain path; micro-band; nucleation; recrystallization

1. Introduction

Rolling is a common deformation technique in sheet manufacturing [1, 2]. During rolling, the downward pressure and the forward fraction would create a resultant force in the sheet, which is termed as shear force. The shear force, especially meeting with the large rolling reduction, would lead to the formation of special microstructure and texture, such as ultrafine grains, shear banding or through-thickness texture when happened to meet materials with high stacking fault energy [3-5]. During rolling,

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