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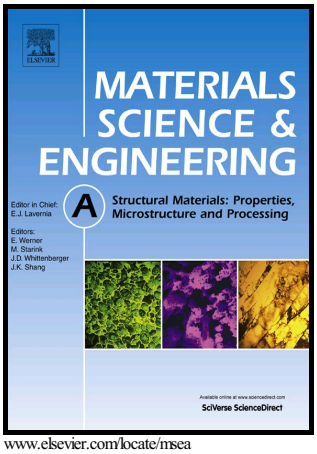

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Effects of cold rolling on microstructure, texture evolution and mechanical properties of Ti-32.5Nb-6.8Zr-2.7Sn-0.3O alloy for biomedical applications

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Abstract:

The effects of cold rolling on the microstructure, texture evolution and mechanical properties of Ti-32.5Nb-6.8Zr-2.7Sn-0.3O (TNZSO, wt%) alloy were investigated. The results showed that the TNZSO alloy exhibits multiple plastic deformation mechanisms and excellent workability during cold rolling. The grains of the alloy were refined and no stress-induced α" phase transformation occurred after cold rolling. The dislocation slipping and {112}<111> type twins appeared in the alloy deformed by 25% and 50%. When the deformation reduction was up to 75% and 90%, dislocation slipping became the main mode of deformation accompanying with the formation of nano-sized grains. With the increase of cold deformation reductions, it was found that the strength and hardness increased owing to the increase of dislocation density and grain refinement, and the elastic modulus obviously decreased owing to the increased dislocation density as well as the enhanced orientation density of $<110>_{\alpha\text{-fiber}}$ textures (including $\{001\}<110>_{\alpha\text{-fiber}}$ and $\{111\}<110>_{\alpha\text{-fiber}}$) and the weakened orientation density of $\{111\}<112>_{\gamma\text{-fiber}}$ texture. The 90% cold deformed alloy exhibited a great potential to become a new candidate for biomedical applications since it possesses low elastic modulus (54.1 GPa), high tensile strength (1093 MPa) and high strength-to-modulus ratio (20.2×10^{-3}), which are superior than those of Ti-6Al-4V alloy.

Keywords: Cold rolling; Ti-32.5Nb-6.8Zr-2.7Sn-0.3O alloy; Microstructure; Texture evolution; Mechanical properties; Biomedical applications.

1 Introduction

Amongst biometallic materials, titanium alloys are the most suitable for use in implants that replace hard tissue [1, 2]. The α+β type Ti-6Al-4V (ELI) alloy is established as one of the major Ti-based alloys used for orthopedic implants, but its elastic modulus (~110 GPa) is much higher than