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Research paper

A thermo-mechanical treatment to improve the superelastic performances of biomedical Ti–26Nb and Ti–20Nb–6Zr (at.%) alloys

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ABSTRACT

A flash-thermal treatment technique has been developed very recently to improve both the critical stress to induce the martensitic transformation (MT) and the recoverable deformation of the metastable β type titanium alloys. In this paper, this strategy is applied to both Ti–26Nb and Ti–20Nb–6Zr (at.%) alloys. Since both alloys have identical martensite start (Ms) temperature, it makes possible to investigate the effect of Zr on mechanical properties after the flash-thermal treatment. It is clearly shown that a flash treatment of 360 s at 873 K on heavily cold-rolled samples results in good balance between the tensile strength, the ductility and the recoverable strains. Such contribution is more significant in the ternary alloy in which balanced properties combining high martensitic critical stress over 400 MPa and the large fully recoverable strains up to 3.0% can be achieved. These improvements are due to the flash treatment effects, resulting in ultra-fine β grains with sizes 1–2 μm with nano-sized α and ω phases precipitation in the β matrix.

1. Introduction

Due to low elastic modulus and superelastic deformation behavior, the metastable β type titanium alloys have been widely investigated as a replacement for NiTi shape memory alloys in biomedical applications (Banerjee et al., 2005; Kim et al., 2004a,b, 2006a,b,c; Laheurte et al., 2010; Miyazaki et al., 2006). Most of the work has been focused on Ti–Nb based alloys to characterize the reversible martensitic transformation (MT) between the β parent phase and the α'' martensite and its influence on the mechanical properties, shape memory effect (SME) and superelastic deformation behavior (Banerjee et al., 2004; Niinomi, 2003; Saito et al., 2003; Yamada, 1992). These achievements brought a better understanding of the

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