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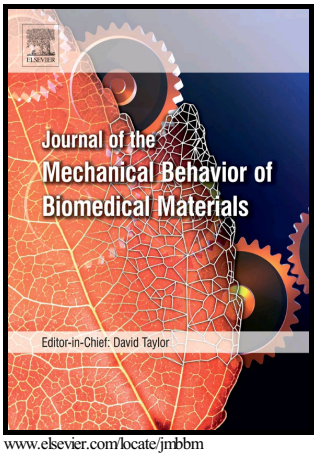

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A bioactive coating with submicron-sized titania crystallites fabricated by induction heating of titanium after tensile deformations

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Abstract

Thermal oxidation technology was widely investigated as one of effective surface modification method for improving the bioactivity and biocompatibility of titanium and its alloys. In this work, the induction heat oxidization method, a fast, efficient, economical and environmental protective technology, was applied to prepare the submicron-morphological oxide coating with variable rutile TiO_2 equiaxed crystallites on the surface of pure Ti substrates after cold-drawing with 10%-20% deformations. The results showed the plastic-deformed Ti cylinders recrystallized during induction heating treatment (IHT) for 10-20 s which resulted in evolution of microstructures as well as slight improvement of microhardness. The surface characteristics of TiO_2 crystallites in oxidation layers were determined by the microstructural evolutions of Ti substrate in terms of the nucleation and growth of TiO_2 crystallites. Specially, the oxidized surface with 50-75 nm roughness and more uniform and finer equiaxed oxide grains remarkablely improved the apatite deposition after bioactive evaluation in 1.5×SBF for 7 days. This work provided a potential method to create controlled bioactive oxide coatings with submicro-/nano-scaled TiO_2 crystallites on titanium substrate in terms of the role of metallographic microstructure in the formation process of titanium oxides.

Keyword: Titanium, Cold-drawing, Induction heating treatment, Oxidation coating, Surface roughness, Hydroxyapatite.

1. Introduction

Titanium and its alloys are widely used in the medical field of orthopedic and dental surgery due to their excellent mechanical properties and good biological performance (Long and Rack, 1998; Geetha et al., 2009). However, various technologies have been applied to modify the surface of titanium and its alloys in order to obtain bioactive and biocompatible coatings and finally improve the osseointegration of these medical items. The surface structure and composition modification are usually performed by mechanical, physical, chemical methods and biomineralization (Liu et al., 2004; Asri et al., 2016). Among the chemical methods, oxidation technology is widely used to prepare bioactive oxide films on the surface of titanium and its alloys, such as chemical, anodic, micro-arc and thermal oxidation etc. (Li et al., 2005; Park et al., 2007; Chrzanowski et al., 2008; Song et al., 2009). Compared with other surface modification methods, thermal oxidation method is more effective, stable and easy-operated. And it can effectively improve the