available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/jmbbm

Research paper

Mechanical and corrosion resistance of a new nanostructured Ti–Zr–Ta–Nb alloy

D. Raducanu[a], *E. Vasilescu*[b,*], *V.D. Cojocaru*[a], *I. Cinca*[a], *P. Drob*[b], *C. Vasilescu*[b], *S.I. Drob*[b]

[a] *Politehnica University of Bucharest, Spl. Independentei 313, 060042 Bucharest, Romania*
[b] *Romanian Academy, Institute of Physical Chemistry "Ilie Murgulescu", Spl. Independentei 202, PO Box 12-194, 060021 Bucharest, Romania*

ARTICLE INFO

Article history:
Received 17 January 2011
Received in revised form
12 April 2011
Accepted 6 May 2011
Published online 13 May 2011

Keywords:
New Ti–10Zr–5Nb–5Ta alloy
Accumulative roll bonding (ARB) processing
Young's modulus
Fracture behaviour
Corrosion resistance

ABSTRACT

In this work, a multi-elementary Ti–10Zr–5Nb–5Ta alloy, with non-toxic alloying elements, was used to develop an accumulative roll bonding, ARB-type procedure in order to improve its structural and mechanical properties. The alloy was obtained by cold crucible semi-levitation melting technique and then was ARB deformed following a special route. After three ARB cycles, the total deformation degree per layer is about 86%; the calculated medium layer thickness is about 13 μm. The ARB processed alloy has a low Young's modulus of 46 GPa, a value very close to the value of the natural cortical bone (about 20 GPa). Data concerning ultimate tensile strength obtained for ARB processed alloy is rather high, suitable to be used as a material for bone substitute. Hardness of the ARB processed alloy is higher than that of the as-cast alloy, ensuring a better behaviour as a implant material. The tensile curve for the as-cast alloy shows an elastoplastic behaviour with a quite linear elastic behaviour and the tensile curve for the ARB processed alloy is quite similar with a strain-hardening elastoplastic body. Corrosion behaviour of the studied alloy revealed the improvement of the main electrochemical parameters, as a result of the positive influence of ARB processing. Lower corrosion and ion release rates for the ARB processed alloy than for the as-cast alloy, due to the favourable effect of ARB thermo-mechanical processing were obtained.

1. Introduction

Titanium and its alloys have been used as implant materials due to their very good mechanical and corrosion resistance and biocompatibility (Niinomi, 2008; Murr et al., 2009). The most used biomaterials were Titanium and its ternary Ti–6Al–4V alloy (Khan et al., 1996; Tamilselvi et al., 2007; Guitar et al., 2009; Ramos-Saenz et al., 2010), especially due to their high mechanical properties. But, some researches prove that Vanadium and Aluminium ions released from this ternary alloy can induce cytotoxic effects or neurological disorders, respectively (Geetha et al., 2009; Van der Voet et al., 1991). Also, for long-term, this alloy has transferred in sufficient load to adjacent bones, resulting in bone resorption and eventual loosening of the implant (McLachlan et al., 1983; Scharnweber, 1998).

Another ternary alloy used as implants was Vanadium free, $\alpha + \beta$ alloy, especially Ti–6Al–7Nb alloy (Lopez et al., 2002; Morand et al., 2003; Lopez et al., 2003) that revealed improved mechanical characteristics, corrosion resistance

* *Corresponding author.* Tel.: +40 213121147; fax: +40 213121147.
E-mail address: ec_vasilescu@yahoo.com (E. Vasilescu).

1751-6161/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jmbbm.2011.05.012