JOURNAL OF THE MECHANICAL BEHAVIOR OF BIOMEDICAL MATERIALS 4 (2011) 284–297

available at www.sciencedirect.com

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

Research paper

The influence of heat treatment and role of boron on sliding wear behaviour of β-type Ti–35Nb–7.2Zr–5.7Ta alloy in dry condition and in simulated body fluids

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ARTICLE INFO

Article history:
Received 10 May 2010
Received in revised form
15 October 2010
Accepted 23 October 2010
Published online 30 October 2010

Keywords:
Titanium alloys
Scanning electron microscopy
Hardness
Wear

ABSTRACT

The wear behaviour of heat-treated Ti–35Nb–7.2Zr–5.7Ta (TNZT) and Ti–35Nb–7.2Zr–5.7Ta-0.5B (TNZTB) alloys (all compositions are in wt%) was investigated in dry condition and in simulated body fluids. It has been found that there is no straightforward relationship between the wear rate and the microstructure. The hardness has no appreciable effect on the wear behaviour of these alloys. The presence of boron in the TNZT alloy deteriorates its wear properties. The wear rate of TNZT and TNZTB alloys in various media increases in the following sequence: dry condition < Hank's solution < bovine serum.

1. Introduction

Friction wear of implant materials is a major clinical problem (Güleryüz and Cimenoğlu, 2004; Hao et al., 2002; Niinomi et al., 1999). Sliding and rubbing action at the contact surfaces of biomedical devices during their service in the body leads to localized stresses at the contact regions and may cause substantial damage on their surfaces. Moreover, the combined effect of corrosion in the human body and corrosion-assisted wear may cause wear to progress very rapidly on the implant (Güleryüz and Cimenoğlu, 2004). In addition, the wear of prosthetic components generates debris and releases particles, which play a major role in implant loosening (Niinomi et al., 1999). The presence of corrosion and wear products in the tissues surrounding the implant may result in a series of events leading to bone loss and ultimately to the failure of the implant (Dearnley et al., 2004; Geetha et al., 2004; Gonzalez-Mora et al., 2003; Kim et al., 2006; Long and Rack, 1998; Niinomi et al., 1999).

Among the conventional surgical implant materials, titanium and several of its alloys are traditionally used as biomaterials because of their excellent combination of corrosion resistance, biocompatibility and mechanical properties (Kobayashi et al., 1998; Niinomi et al., 1999; Williams, 2001). They are generally preferred to stainless steels and Co–Cr alloys because of their high strength to density ratio, superior biocompatibility and corrosion resistance, good mechanical properties and low elastic modulus (Hao et al., 2002; Velten

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1751-6161/$ - see front matter
doi:10.1016/j.jmbbm.2010.10.007