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Research paper

Wear resistance of experimental titanium alloys for dental applications

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ARTICLE INFO

Article history:
Received 18 January 2011
Received in revised form
4 June 2011
Accepted 6 June 2011
Published online 14 June 2011

Keywords:
Sliding wear
Titanium alloys
Dental applications
Two-body abrasion
Wear testing
Hardness tests

ABSTRACT

The present study evaluated microstructure, microhardness and wear resistance of experimental titanium alloys containing zirconium and tantalum. Alloys were melted in arc melting furnace according to the following compositions: Ti–5Zr, Ti–5Ta and Ti–5Ta–5Zr (%wt). Hemispheres and disks were obtained from wax patterns that were invested and cast by plasma. Microstructures were evaluated using optical microscopy and X-ray diffraction (XRD) analysis and also Vickers microhardness was measured. Hemispherical samples and disks were used for 2-body wear tests, performed by repeated grinding of the samples. Wear resistance was assessed as height loss after 40,000 cycles. The data were compared using ANOVA and post-hoc Tukey test. Ti–5Zr presented a Widmanstätten structure and the identified phases were α and α' while Ti–5Ta and Ti–5Ta–5Zr presented α, β, α' and α" phases, but the former presented a lamellar structure, and the other, acicular. The microhardness of Ti–5Zr was significantly greater than other materials and cp Ti presented wear resistance significantly lower than experimental alloys. It was concluded that wear resistance was improved when adding Ta and Zr to titanium and Zr increased microhardness of Ti–5Zr alloy.

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1. Introduction

The use of commercially pure titanium (cp Ti) has been increased in dental appliances because of its good mechanical properties, excellent corrosion resistance, good biocompatibility and high strength-to-weight ratio (Okabe and Hero, 1995). However, there are still some difficulties to be overcome for successful titanium application in dentistry, especially in prosthodontics. One of the problems is that unalloyed titanium properties are not strong enough for some dental applications (Ho et al., 2008). In addition, the use of titanium has been limited because of inherent casting problems that are caused by high titanium melting point, reactivity with investment materials and low density, creating difficulties to achieve complete mold filling (Lautenschlager and Monaghan, 1993).

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1751-6161/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jmbbm.2011.06.004