Biomaterials and Biomechanics in Bioengineering, *Vol. 1, No. 3 (2014) 117-130*
(Formerly, Biomaterials and Biomedical Engineering)
DOI: http://dx.doi.org/10.12989/bme.2014.1.3.117

Micro-hardness and Young's modulus of a thermo-mechanically processed biomedical titanium alloy

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(Received June 06, 2014, Revised September 25, 2014, Accepted September 30, 2014)

Abstract. This paper presents a study on the influence of different thermo-mechanical processing (TMP) parameters on some required properties such as micro-hardness and Young's modulus of a novel near β alloy Ti-20.6Nb-13.6Zr-0.5V (TNZV). The TMP scheme comprises of hot working above and below β phase, solutionizing treatment above and below β phase coupled with different cooling rates. Factorial design of experiment is used to systematically collect data for micro-hardness and Young's modulus. Validity of assumptions related to the collected data is checked through several diagnostic tests. The analysis of variance (ANOVA) is used to determine the significance of the main and interaction effects. Finally, optimization of the TMP process parameters is also done to achieve optimum values of the micro-hardness and Young's modulus.

Keywords: titanium alloys; biomedical applications; micro-hardness; Youngs's modulus; ANOVA

1. Introduction

Titanium (Ti) and its alloys are considered the best choice for replacing or repairing failed hard tissues (structural biomedical applications) as these materials present excellent biocompatibility, high strength to density ratio, outstanding corrosion resistance as well as low modulus of elasticity (Wang 1996, Long *et al.* 1998, Niinomi 2003).

Multifunctional β-type Ti alloys which widely used in various biomedical applications have been developed all over the world. Recently, some new metastable β-type Ti alloys containing β-stabilizers such as Nb and Zr have attracted much special attention for orthopedic implants applications owing to their unique combination of better mechanical properties, low elastic modulus, superior biocorrosion resistance, nontoxicity against osteoblastic cells, no allergic problems, and excellent biocompatibility. The required mechanical properties in this kind of Ti alloys can be improved due to solid solution and second phase strengthening while preserving the

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 ISSN: 2288-3738 (Print), 2288-3746 (Online)

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