Nanotube Shape Variation on the Ti-xNb Alloys with Alloying Elements and Applied Potentials

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Abstract: The purposed of this work was to determine nanotube shape variation on the Ti-xNb alloys with alloying elements and applied potentials. Samples were prepared by arc melting, followed by followed by homogenization for 12 hr at 1000 ° C in argon atmosphere. This study was evaluated the phase and microstructure of Ti-xNb alloys using an X-ray diffraction (XRD) and optical microscopy (OM). The morphology of the samples was investigated with a field-emission scanning electron microscope (FE-SEM) and energy dispersive X-ray spectroscopy (EDS). The nanotube on the alloy surface was formed in 1 M H_3PO_4 with small additions of NaF 0.8 wt.%. All anodization treatments were carried out using a scanning potentiostat (Model 362, EG&G, USA) at constant voltage 30 V for 120 min, respectively. The morphology of the samples was investigated with a field-emission scanning electron microscope (FE-SEM) and energy dispersive X-ray spectroscopy (EDS). Surface characteristics of nanotbue formed on Ti-xNb alloys was investigated by potentiodynamic test and potentiostatic in 0.9% NaCl solution at 36.5±1℃. It was observed that the changed α phase to β phase with Nb content.

1. Introduction

Titanium (Ti) and its alloys are fast emerging as the most attractive choice for the majority of medical applications. Especially the Ti-6Al-4V alloy has been an important biomaterial in this field for a long period, due to its high specific strength, excellent corrosion resistance, and superior biocompatibility. However releases toxic (Al and V) ions into the body, which have the potential of causing undesirable long-term effects such as Alzheimer's disease and cytotoxic reactions. Recently, new β-type titanium alloys composed of non-toxic and β-stabilizing elements such as Nb have been developed as implant materials. Among the various methods to improve the interfacial properties and clinical lifetime of Ti-based implants, anodization has attracted great attention due to controllable, reproducible results as well as simple processing. Also, for the improvement of biocompatibility of Ti alloy, we need the two scale surface modification, that is, nano-scale for bioactivity of the implant and micro-scale for osteoblast adhesion. Therefore, in this study, nanotube shape variation on the Ti-xNb alloys with alloying elements and applied potentials was researched using various experimental instruments.

2. Experimental

In this work, Ti-xNb binary alloys contained from 10 wt. % to 50 wt. % contents were manufactured by vacuum arc-melting furnace. The ingots of Ti-xNb alloys were homogenized in Ar atmosphere at 1000 ℃ for 2 h followed by quenching into 0 ℃ water. The formation of nanotubular film was conducted by electrochemical method in mixed electrolytes with 1 M H_3PO_4+ 0.8 wt.% NaF with various applied potential from 10 V to 40 V. The surface characteristics were investigated using field emission scanning electron microscopy (FE-SEM), x-ray diffract meter (XRD), X-ray fluorescence (XRF) and, energy dispersive X-ray spectroscopy (EDS). The nanotubes formed on the Ti-xNb alloys surface were transformed from the anatase to rutile structure of titanium oxide. Surface characteristics of nanotbue formed on Ti-xNb alloys was investigated by potentiodynamic test and potentiostatic in 0.9% NaCl solution at 36.5±1℃.

3. Conclusions

It was observed that the changed α phase to β phase with Nb content. Nanotbue shape on Ti-xNb alloys can be controlled by applied potential and alloying elements. The nanotubes formed on the Ti-xNb alloys surface were transformed from the anatase to rutile structure of titanium oxide. (Supported by NRF: 2013 R1A1A 2006203;hcchoe@chosun.ac.kr).

Reference

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