# Morphology Change of Nanotube and Micropore on the Ti-25Nb-xHf Alloys with Hf Contents after Anodization

Sung-Hwan Kim, Yeong-Mo Ko, Han-Cheol Choe*
[b]Department of Dental Materials, Research Center of Nano-Interface Activation for Biomaterials, & Research Center for Oral Disease Regulation of the Aged School of Dentistry, Chosun University, Gwangju, Korea

**Abstract:** In this study, we investigated morphology of nanotube and micropore on the Ti-25Nb-xHf alloys with Hf contents after anodization. Ti-25Nb-xHf ternary alloys contained from (0~15) wt.% Hf contents were manufactured by vacuum arc-melting furnace. The obtained ingots were homogenized in an argon atmosphere at 1000°C for 12h and then water quenching. The specimens were cut from ingots to 3mm thickness and first ground and polished using SiC paper (grades from 100 to 2000). 2steps anodization treatments on Ti-25Nb-xHf alloys were carried out at room temperature for experiments. Micro-pore formation was performed in Ca+P mixed solution at 265V for 3min. After that, nanotube formation was in 1M $H_3PO_4$ electrolytes containing 0.8wt.% NaF solutionat 10V for 120min. Morphologies of micropore and nanotube depended on the Hf content in Ti-25Nb-xZr ternary system.

## 1. Introduction

Commercially pure titanium and titanium alloy are preferred for dental and orthopedic implant or prosthesis because of their corrosion resistance, biocompatibility, durability and strength. but Al and V of Ti-6Al-4V alloy are released from the alloy inside the body and these ions mix in the main body stream. Recent research on metallic biomaterials has focused on Ti alloys composed of non-toxic elements like Nb, Ta, Mo, Hf and Zr, in order to overcome the long-term healthy problem caused by the release of toxic metal ions. Moreover, Nb is found to reduce the modulus of elasticity when alloyed with Ti, Hf leads to better corrosion resistance due to the formation of a stable oxide surface layer. To achieve improved osseointegration, there have been many efforts to modify the composition and topography of implant surface.

Recently, the anodic oxidation treatment of titanium metal has attracted a great deal of attention. The anodization method provides an effective coating technology for titanium alloys because large-area coatings can be achieved with good mechanical adhesion for biocompatibility. The formation of micro-pores by spark anodization is one of the conventional processes, and this process is very easy and fast that leads to the formation of highly dense oxide structure with 1 to 10 ㎛. and As $TiO_2$ nanotubes have shown excellent physical and chemical properties that are favorable for many applications including biomedical applications as well as good bioactivity in simulated body fluids and cell culture.

## 2. Experimental

In this paper, Ti-25Nb-xHf ternary alloys contained from (x=0, 3, 7, 15) wt.% Hf contents were manufactured by vacuum arc-melting furnace. The obtained ingots were homogenized in an argon atmosphere at 1000°C for 12h and then water quenching. The specimens were cut from ingots to 3mm thickness and first ground and polished using SiC paper (grades from 100 to 2000). 2steps anodization treatments on Ti-25Nb-xHf alloys were carried out at room temperature for experiments. Micro-pore formation was performed in 0.2M calcium acetate monohydrate and 0.02M calcium glycerophosphate at 265V for 3min. After that, nanotube formation was in 1M $H_3PO_4$ electrolytes containing 0.8wt.% NaF solutionat 10V for 120min. The morphology change of anodized Ti-25Nb-xHf alloys were determined by field emission scanning electron microscopy (FE-SEM), x-ray diffractometer (XRD).

## 3. Conclusions

Morphologies of micropore and nanotube depended on the Hf content in Ti-25Nb-xZr ternary system.
(This research was supported by NRF: R13-2008-010-00000-0)

## Reference

1. Y. H Jeong, K. Lee. H. C. Choe, Y. M. Ko, W. A. Brantley, Thin solid Films 517 (2009) 5365-5369
2. Y. Li, I. S. Lee, F. Z. Cui, S. H. Choi, Biomaterials, 229 (2008) 2025-2032
3. L. H. Li, Y. M Kong, H. W. Kim, Y. W. Kim, H. E. Kim, S. J. Heo, J. Y. Koak, Biomaterials 25 (2004) 2867-2875