Electrochemically Fromed Nanotube Shape on Ternary Ti Alloy with Hf Content

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Abstract: In this study, we investigated electrochemically formed nanotube shape on ternary Ti-25Ta-xHf alloys with Hf contents. Ti-25Ta-xHf (x=0~15 wt.%) alloys were manufactured by vacuum arc-melting furnace. The obtained ingots were homogenized in an argon atmosphere at 1050° C for 2h and then water quenching. The specimens were cut from ingots to 4 mm thickness and first ground and polished using SiC paper (grades from #100 to #2000). The anodization treatments on Ti-25Nb-xHf alloys were carried out at room temperature for experiments. The formation of nanotubular film was conducted by electrochemical method in mixed electrolytes with 1 M H_3PO_4 + 0.8 wt. % NaF at 30 V for 2 h. The morphologies of nanotube depended on the Hf content in Ti-25Ta-xHf ternary system.

1. Introduction

Titanium and its alloys (particularly Ti-6Al-4V) are widely used as implants in orthopedics, dentistry and cardiology due to their high strength, enhanced biocompatibility. These biomaterials, however, can cause potentially serious health problems because they release toxic metal ions and can lead to the resorption of adjacent bone tissues due to the large difference in their elastic modulus and that of the adjacent bone tissues. Accordingly, some research groups have focused on Ti-Nb-Zr, Ti-Ta-Zr, Ti-Nb-Hf, and Ti-Ta-Hf systems, controlling the contents of these recommended alloying elements for titanium. Tantalum is of considerable interest because it is one of the most effective titanium β-phase stabilizing elements and Ta can reduce the elastic modulus when alloyed with Ti. Also, it would be expected that Ti-Ta alloys containing Hf have a good corrosion resistance, since Hf has complete mutual solubility in both α phases and β phases of titanium.

In order to design better implant materials, it is important to understand the events at the bone-material interface. Nanotube titanium oxide formation on the titanium or titanium alloy surface is important to improve cell adhesion and proliferation in clinical use. It should be possible to control the nanotube size and morphology for biomedical implant use by controlling the applied voltage, alloying element, anodization time. Therefore, in this study, we investigated electrochemically formed nanotube shape on ternary Ti-25Ta-xHf alloys with Hf contents.

2. Experimental

The Ti-25Ta-xHf ternary alloys contained from 0 wt. % to 15 wt. % contents were manufactured by vacuum arc-melting furnace. The ingots of Ti-25Ta-xHf alloys were homogenized in Ar atmosphere for 12 h at 1000 ℃ 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 at 30 V for 2 h. The phase and microstructure of Ti-25Ta-xHf alloys were investigated by using an X-ray diffractometer (XRD) and optical microscopy (OM). The morphology of the samples was investigated with a field-emission scanning electron microscope (FE-SEM).

3. Conclusions

The morphologies of nanotube depended on the Hf content in Ti-25Ta-xHf ternary system.
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Reference

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