Effect of EB-PVD Coated Si/HA Film Thickness on Surface Characteristics of Ti-35Nb-10Zr Alloy

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Abstract: In this study, effect of EB-PVD coated Si/HA film thickness on surface characteristics of Ti-35Nb-10Zr alloy was investigated. The Ti-35Nb-10Zr alloy was fabricated by arc melting method. The Si/HA layers were coated with 0.8 wt.% of Si in pure HA by EB-PVD method. The coating thickness was consisted with 100 - 300 nm for each group, the surface characteristics was analyzed by FE-SEM, EDS, XRD, XRF and corrosion test. The Si/HA coating layer was well deposited on the alloy surface by EB-PVD, the thickness was correlative factor with HA peaks and corrosion resistance value.

1. Introduction

The number of patients demanding and requiring dental implant and bone and joint replacement are constantly increasing. Hydroxyapatite (HA) coatings on the metallic prostheses have been studied widely used due to combination of advantage of the mechanical properties of metals and the bioactivity of HA. Compared bone apposition to pure HA and silicon substituted HA (Si/HA), demonstrating that bone apposition is significantly increased at the surface of silicon substituted HA. Especially, the levels of bone apposition, in growth and adaptive remodeling were remarkably affected by the Si content of the Si/HA, with 0.8 wt.% Si showing the optimal response for both of bone forming and bone absorbing cells. Regarding as a coating method, the electron beam physical vapor deposition (EB-PVD) method can be have a confidence of high density and bonding strength between HA coating and substrate, and can easily control the coating rate and thickness, and the appropriate coating thickness is the essential requirement of high reliable aspect for bonding and degradation properties. In terms of substrate for biocompatible coating, β phase type of titanium alloys have low elastic modulus, one of these type, the Ti-35Nb-10Zr alloy shows both of low elasticity and non cytotoxicity.

In this study, effect of EB-PVD coated Si/HA film thickness on surface characteristics of Ti-35Nb-10Zr alloy was investigated using various experimental methods.

2. Experimental

For this work, Ti-35Nb-10Zr alloy was prepared by arc melting method, and homogenized at 1000 °C, after that was water quenched to have a β phase. The Si/HA coating was prepared by EB-PVD method with 0.8 wt.% of Si contents, coating thickness was monitored by comparing of acoustic impedance to have 100, 200 and 300 nm for each group. The characteristics of coating surface and thickness were analyzed by field emission scanning electron microscopy (FE-SEM) coupled with energy dispersive spectroscopy (EDS) and X-ray diffractometry (XRD) and X-ray fluorescence (XRF). To know the information of degradation on the coating surface, the potentiodynamic and AC impedance test was performed in 0.9 wt.% NaCl solution at 36.5 ± 1 °C.

3. Conclusion

This work shows that the higher thickness of Si/HA coating layer had more frequent XRD peaks of HA, and had less rate of ion release on titanium substrate. The Ca/(P+Si) ratio in Si/HA coatings was around 1.6-1.7, which was close to the Ca/P ratio in the HA. (hcchoe@chosun.ac.kr; This research was supported by NRF-2011-375-E00049)

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