The Biocompatibility of HA Film Deposition on Anodized Titanium Alloy

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Abstract: A thin film hydroxyapatite (HA) films was deposited on anodized titanium by RF sputtering method. The anodized titanium enhanced the biocompatibility of the Ti and the bioactivity was improved further by the HA deposited on the anodized Ti. TiO_2 layer with 0.2 ~ 0.5 ㎛ diameter pore size was formed on the Ti surface by anodization. Anodized TiO_2 layer analysis HA film deposited, oxide pore size and number decreased compared with non-HA deposited surface. The corrosion resistance of HA deposited/anodized Ti was higher than that of the non-treatment Ti alloy in Hank's solution, indicating better protective effect. From the results of cell culture using MTT assays, the best cell proliferation showed in HA deposited surface after anodization of Ti surfaces compared with another surface treatment.

1. Introduction

Commercial pure titanium and titanium based alloys are widely used as a dental root implant material in clinical dentistry and as an orthopedic implant material. Surface modifications are widely used to adjust the properties of the titanium surface to the specific needs of the particular medical applications, but there are certain disadvantages such as poor osteoconductive properties and low corrosive-wear resistance.

Hydroxyapatite (HA, $Ca_{10}(PO_4)_6(OH)_2$) has been widely used as a coating materials for dental and orthopedic implants for many years, due to close similarity of chemical composition and high biocompatibility with natural bone tissue. However, interfacial bond strength of the HA coating on the Ti substrate without anodization is observed to be low. Also the research on biocompatibility on the Ti substrate after anodization was rare. In this work, HA thin film deposition has been carried out on an anodized titanium surface and then the biocompatibility of HA film deposition on anodized titanium alloy have been researched.

Materials and Methods

Commercial pure titanium (Cp-Ti, Grade 2) and Ti-6Al-4V ELI were used as a substrate material for coating the TiO_2. The titanium plates were cut down to 20 mm diameter and 1 mm thick discs. The metal surface was incrementally polished by utilizing 120 grit emery paper down to 2000 grit emery paper. So chemically clean/etching for 5 min in 5.5 M of HNO3with few drops of HF (ACS grade, Fisher Scientific, Pittsburg, PA), rinse by distilled water and dried at nitrogen gas blowing. The polished and cleaned titanium disks were anodized in solution containing typically 1 M H_3PO_4 at room temperature. A direct current (D.C) power source was used for the process of anodic oxidation. The HA coating was produced by reactive RF magnetron sputtering on anodized TiO_2 layer, using target of HA (99.99%). A RF power of 50W was applied to the target during 40 min for all the depositions, obtaining an average with a constant substrate temperature of 100 ℃¡É. A set of coating was obtained with constant argon gas flow of 40 sccm. Film surface topology, chemical composition, crystal structure, and corrosion behavior were determined using scanning electron microscopy (SEM), energy dispersive x-ray spectroscopy (EDS), X-ray diffraction (XRD), and electrochemical equipments. The corrosion behaviors were investigated using potentiostat (EG&G Co, 263A. USA) in Hank's solution at 36.5 ± 1℃. For the in vitro tests, the MG63 cell lines were used to characterize the proliferation, MTT test.

Conclusions

A thin and uniform HA film was deposited on anodized Ti substrate by the RF sputtering to improve its biocompatibility. TiO_2 layer with 0.15 ~ 0.2 ㎛ diameter pore size was formed on the CP Ti surface by anodization. From the anodized layer analysis after HA deposition, oxide pore size and number decreased compared with anodized Ti surface. The corrosion resistance of HA deposited on anodized Ti was higher than that of the non-treatment Ti alloy in Hank's solution, indicating better protective effect.

From the results of cell culture using MTT assays, the best cell proliferation showed in HA deposited surface after anodization of Ti surfaces compared with another surface treatment.

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