Mg-Doped Hydroxyapatite Coatings Film on Anodized Ti-xTa Alloys for Dental Materials

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The CP-Ti and Ti-6Al-4V ELI have been intensively studied for the applications of orthopedic and dental implants because of its excellent mechanical properties, corrosion resistance, and biocompatibility, but it is not strong enough for some dental application. The elastic modulus of human cortical bone is as low as 18 GPa, whereas most metallic implant materials have approximately six- to tenfold higher elastic modulus than cortical bone. Such a large difference in the elastic modulus between a bone and an implant can cause bone resorption induce by stress shielding. Moreover, the Ti-6Al-4V alloy is currently used and should be replaced because the release of Al and V ions causes long-term health problems. Thus, there are efforts for developing new titanium alloys with nontoxic elements. In our research group, it was reported that Ti-30Ta alloys exhibited very low elastic modulus of 60 GPa. To achieve improved osseointegration, there have been many efforts to modify the composition and topography of these implant surfaces. Hydroxyapatite was widely used as coating ceramic for orthopedic and dental applications given its excellent biocompatibility and strong bonding with natural bones. HAp ceramics can be doped with small amounts of ions that are found in natural bones and tooth mineral. HAp coatings doped with magnesium(Mg) ion is an attractive method to improve the biocompatibility and biodegradability of HAp coatings.

In this paper, we prepared Mg-doped hydroxyapatite coatings film on anodized Ti-xTa (x=10 to 50 wt.%) alloys for dental materials by electrochemical deposition. The deposition process involved two steps, 1) TiO_2 micro-pore formation on Ti-xTa alloys at high current anodization treatment; 2) the electrochemical deposition method was carried out in Mg-ion contained electrolyte for nano-phase HAp deposition on anodized Ti-xTa surface. The electrolyte was a composite solution of $Ca(NO_3)_2 \cdot 4H_2O$, $NH_4H_2PO_4$, and $Mg(NO_3)_2$ in deionized water, with (Ca + Mg)/P molar ration being 1.67. Finally, all coatings were gently rinsed in deionized water and dried at the room temperature. Meanwhile, the pure HAp coatings were prepared as the control group. The morphology and crystalline structure of nano-phase Mg/HAp film on the anodized Ti-xTa alloys surface were characterized by thin film XRD and FESEM.

Elemental analysis was performed using an EDS. It is expected that Ti-xTa alloys having a high biocompatibility can be obtained by applying the Mg-ion doped nano-phase HAp deposition after the electrochemical anodization(Supported by NRF: 2013 R1A1A 2006203; hcchoe@chosun.ac.kr).

[1] H. C. Choe, Nanotubular surface and morphology of Ti-binary and Ti-ternary alloys for biocompatibility, Thin Solid Films 519, 4652 (2011).