Electrochemical Characteristics of Octacalcium Coatings on Plasma Electrolytic Oxidized CW-titanium Surface

Kyeong-Tae Kim[1], Han-Choel Choe[1]

[1]*Author's Advanced Funtional Surface and Biomaterials Research Lab, Department of Dental Materials and Convergence Research Center for Treatment of Oral Soft Tissue Disease (MRC), College of Dentistry, Chosun University, Gwangju*

Presenter's e-mail address: hcchoe@chosun.ac.kr

Abstract Pure titanium and its alloys are primarily used in dental implants. However, surface inactivation can delay the healing process after clinical surgery. As a result, various studies are exploring the coating of bioactive materials. OCP (Octacalcium Phosphate) is one of the naturally occurring calcium phosphates in living organisms. It degrades safely in biological conditions and is known as a precursor to biological apatite crystals found in bones and teeth due to its crystallographic similarity. The corrosion impact of mechanically and electrochemically coating OCP onto cold-worked pure titanium(CW-Ti) surfaces treated by plasma electrolytic oxidation (PEO) was comparatively investigated.

The mechanical coating process was carried out using 30g of OCP powder and zirconia balls at 35rpm for 6 hours, while the electrochemical coating process involved electrodeposition using a solution of 0.042M $Ca(NO_3)_2$ and 0.025M $NH_4H_2PO_4$. The corrosion resistance of the coatings was measured in 0.9% NaCl solution using AC impedance and potentiodynamic polarization. Additionally, FESEM was used to analyze the microstructural characteristics before and after PEO treatment and corrosion testing. The experiments were repeated under consistent conditions to ensure statistical significance.

The results of this study showed differences depending on the coating method. The mechanical method resulted in OCP filling the PEO pores, while the electrochemical method caused OCP to form around the pores, leading to different outcomes. However, both methods exhibited higher impedance compared to samples without OCP, indicating that OCP delayed the diffusion or mass transport of ions or reactants at the electrode-electrolyte interface. This led to the formation of a protective layer on the electrode surface, reducing the overall corrosion rate. These findings confirm the

potential of OCP coatings to protect against corrosion in implants. (Supported by National Research Foundation of Korea: 2023-GJ-RD-0008; hcchoe@chosun.ac.kr).

Keywords Cold-worked pure titanium, Octacalcium phosphate, Plasma electrolytic Oxidation, Mechanically coating, Electrochemical coatings and characteristics

Reference

[1] S.S. Nisar, S. Arun, H.C. Choe, Plasma electrolytic oxidation coatings on femtosecond laser-treated Ti-6Al-4V alloy for bio-implant use, Surf. Coat. Technol. 464 (2023) 129553, https://doi.org/10.1016/j.surfcoat.2023.129553.

[2] K.T. Kim, S.S. Nisar, H.C. Choe, Mechanical octacalcium phosphate coatings on the plasma electrolytic oxidized pure titanium for bio-implant use, Surf. Coat. Thehnol. 480 (2024) 130602, https://doi.org/10.1016/j.surfcoat.2024.130602.

[3] S.Y. Joo, S.S. Nisar, J.K. Lee, H.C. Choe, Calcium silicate ceramic coatings on the plasma electrolytic oxidized Ti-6Al-4V alloy using spin coating method, Surf. Coat. Thehnol. 479 (2024) 130575, https://doi.org/10.1016/j.surfcoat.2024.130575.