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**DP10** Nanotube Shape and Morphology Control of Ti-6Al-4V by Various Applied Potential for Drug Doping and Bioactive Materials Coating

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CP Ti and Ti-6Al-4V alloy has been widely used for implant materials such as dental and orthopedic implants due to a good mechanical property, corrosion resistance, and biocompatibility. Even though these advantages, many researchers have focused on the surface modification for improvement of biocompatibility on interface between implant and bone.

Especially, one of surface modification methods is nanotube formation on the alloy for improvement for biocompatibility. It is possible to form nanotubes on the surface of the implant alloy under the conditions of constant voltage in general. However, in this study, given the gradual change of the various applied potential, to nanotube formation, was studied how nanotubes form would change accordingly for drug doping and bioactive materials coating.

In this study, nanotube shape and morphology control of Ti-6Al-4V alloy by various applied potentials for drug doping and bioactive materials coating have been researched by using electrochemical methods in 1 M H$_2$PO$_4$ with small amounts of fluoride ions. The nanotube formation was carried out by DC power supply with applied voltage variation in range of 10−40V after washing three times with distillation water for 15 minutes. Nanotube shape and morphology was observed by FE-SEM, EDS, XRD, STEM, AFM, XPS. Nanotube shape can be controlled by applied potential for drug doping and bioactive materials coating.

**Keywords:** Ti-6Al-4V alloys, Applied potential, Nanotube shape, Drug doping, Coating

**DP11** Electrochemically Hydroxyapatite-precipitated Nanotubular Ti-35Ta-xNb Alloys, ChaeEk Jo, Chosun University, Republic of Korea

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The β-type titanium alloys are advantageous for the development of titanium alloys with low Young’s modulus for biomedical applications. Young’s modulus of dental implant is important to osseointegration of human bone for decreasing the stress shielding. In such conditions, bone atrophy occurs and leads to the loosening of the implant and refracting of the bone. In order to forming β-type titanium alloys, titanium alloys have encouraged the search for new Ti-based biomaterials non-toxic and non-allergic element such as Nb, Ta, Zr, Hf, Mo, and Sn. Hydroxyapatite (HA) coating on the surface of biomedical materials such as Ti-6Al-4V has many biological benefits such as direct bonding to bone and enhancement of new bone formation around it due to its chemical similarity with hard tissues. Many Electrochemical deposition method is one of the many coating methods for dental implant, electrochemical coating method on titanium alloys is an attractive process because highly irregular objects can be coated relatively quickly at low temperatures. Additionally, the thickness and chemical composition of coatings can be well controlled through adequate conditions of the process. Also, nanotube formation is observed that the size of the nanotubes can affect cell proliferation and adhesion.

In this study, we researched electrochemically hydroxyapatite-precipitated nanotubular Ti-35Ta-xNb alloys for biomedical application. The Ti-35Ta-xNb alloys contained from 0 wt. % to 15 wt. % Nb contents were manufactured by arc melting furnace. The surface treatment was performed using anodizing electrolyte of 1 M H$_2$PO$_4$ containing 1.2 wt. % NaF for 1 h. HA thin film coatings were prepared by electrochemical deposition that was carried out using cyclic and voltammetry (CV) method at 85 °C in 5 mM Ca(NO$_3$)$_2$ + 3 mM NH$_4$H$_2$PO$_4$. The coated surface morphology of nanotube structured Ti35Ta-xNb alloy was examined by FE-SEM, EDS, and XRD. It was found that HA coating surface on the nanotube structured Ti-35Ta-xNb alloys have good biocompatibility and good corrosion resistance for biomedical application.

**Keywords:** Ti-6Al-4V alloys, Applied potential, Nanotube shape, Drug doping, Coating

**DP12** Nanotube Formation Phenomena on Ti-25Nb-xZr Alloys with Zr Content and Applied Potential

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Cp-titanium and Ti-6Al-4V alloys are metallic materials used as a dental implant and orthopedic implants. However, there are some problems of Ti-6Al-4V alloy such as Alzheimer’s disease of aluminum, toxicity of vanadium, high elastic modulus, and low corrosive-wear resistance. These concerns have led to the development of new type titanium alloys without aluminum and vanadium. It has been reported that, β rich Ti-Nb-Zr alloys are better substitutes, as these materials possess low modulus and consists of non-toxic elements. The Nb present in these alloys, a known allergic element such as Nb, Ta, Zr, Hf, Mo, and Sn. Hydroxyapatite (HA) coatings on the implant biomaterials have many biological benefits such as direct bonding to bone and enhancement of new bone formation around it due to its chemical similarity with hard tissues. Many Electrochemical deposition method is one of the many coating methods for dental implant, electrochemical coating method on titanium alloys is an attractive process because highly irregular objects can be coated relatively quickly at low temperatures. Additionally, the thickness and chemical composition of coatings can be well controlled through adequate conditions of the process. Also, nanotube formation is observed that the size of the nanotubes can affect cell proliferation and adhesion.

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**Keywords:** Ti-6Al-4V alloys, Applied potential, Nanotube shape, Drug doping, Coating

**DP13** The Tribocorrosion of CoCrMo Alloys Coated with TiAlN/TiAlPt Multilayers

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The tribocorrosion phenomenon is present in biomedical alloys that are used in artificial implants to replace natural joints. This damage limit the service life of such implants, the hard coatings can improve the resistance of wear and corrosion. The main objective of this paper is to find on CoCrMo alloys by magnetron sputtering. In this work we study the wear mode of the samples coated and alone in a simulated body fluid with an ion concentration similar to that in the human blood. The structure of coatings was studied by means of XRD and the composition by RBS and EDS techniques. The tribocorrosion behavior of CoCrMo alloys alone and coated with TiAlN/TiAlPt multilayers was studied in simulated body fluid. The tribocorrosion was performed using a ball on plate apparatus. The loaded tests were conducted at 37 °C of temperature. The loads used were between 0.25 N to 2N, the oscillating frequencies was 1Hz. The corrosion and tribocorrosion were studied using open circuit potential (OCP) and potentiodynamic polarizations. The potentiodynamic polarization was used to estimate the change in the corrosion rate due to wear and the potentiostatic polarization in the passive region to measure the change in the wear rate due to corrosion. In order to study the wear mechanisms, the debris, the topography and composition of worn surfaces were analyzed by means of SEM and EDS. For the CoCrMo alloy the corrosion augmentation factor was greater than the wear augmentation factor. The coatings improve the corrosion and tribocorrosion resistance of CoCrMo alloys.

**Keywords:** Ti-6Al-4V alloys, Applied potential, Nanotube shape, Drug doping, Coating

**DP14** Enhanced Corrosion Resistance and Hemocompatibility of Biomedical NiTi Alloy by Atmospheric-pressure-precipitated Fluorine-rich Coating

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To improve the corrosion resistance and hemocompatibility of biomedical NiTi alloy, hydrophobic polymer coatings are deposited by plasma polymerization in the presence of a fluorine-containing precursor by an atmospheric-pressure plasma jet. This process takes place at a low temperature in air and can be used to deposit fluoropolymer films using organic compounds that cannot be achieved by conventional techniques. The composition and chemical states of the polymer coatings are characterized by Fourier transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). The corrosion behavior of the coated and bare NiTi samples is assessed and compared using polarization tests and electrochemical impedance spectroscopy (EIS) in physiological solutions including simulated body fluids (SBF) and Dulbecco's Modified Eagle's Medium (DMEM). The corrosion resistance of the coated NiTi alloy is evidently improved. Protein adsorption and platelet adhesion tests reveal that the adsorption ratio of albumin to fibrinogen is increased and the number of the adherent platelets is greatly reduced on the coating. The plasma polymerized coating produces better hemocompatibility and is promising as a protective and hemocompatible coating on cardiovascular implants.

**Keywords:** NiTi, Fluorine-rich coating, Corrosion behavior, Hemocompatibility
DP15  Enhanced Osteogenic Activity on Platform of Titanate Nanotube Arrays, Xuming Zhang, L.M. Li, W.H. Jin, P.H. Li, City University of Hong Kong, Hong Kong Special Administrative Region of China, L.Z. Zhao, The Fourth Military Medical University, China, K.F. Huo, Huazhong University of Science and Technology, China, P.K. Chu (paul.chu@cityu.edu.hk), City University of Hong Kong, Hong Kong Special Administrative Region of China

Titanium (Ti)-based dental and orthopedic implants are widely used clinically, but insufficient osseointegration and associated infection may occur after implantation. Hence, materials improvement is necessary. Highly ordered titania nanotubes (TiO$_2$-NTs) fabricated on Ti implants by electrochemical anodization have attracted increasing attention. TiO$_2$-NTs have a lower elastic modulus of approximately 36-43 GPa which is much closer to that of natural bones and are expected to have better biomechanical compatibility than other artificial biomaterials. They are also promising bioactive coatings that can induce direct bone-implant bonding and enhanced host defense on the implant surface. More importantly, the hollow structure in the TiO$_2$-NTs with the proper dimensions not only alter the cell behavior and foster the growth of nano-structured hydroxyapatite in simulated body fluids, but also act as an excellent drug delivery platform, particularly for inorganic bioactive elements. Our previous work shows that the hierarchically hybrid TiO$_2$-NTs and silver particles are stable and can generate long-lasting delivery effects. Elements such as strontium (Sr) and zinc (Zn), have aroused clinical interests because of the pronounced effects in reducing the bone fracture risk in osteoporotic patients, antibacterial ability, as well as anabolic effects on bone metabolism by stimulating osteoblast proliferation and mineralization. However, it is challenging to achieve stable and long-lasting trace element release. Here, we report a more efficient delivery platform capable of controlled trace element release by transforming the TiO$_2$-NTs into titanate-NTs and the nanotubular structure is preserved despite the hydrothermal treatment. Our results show that a titanate-NT coating incorporated with the optimal element (Sr and Zn) and dose allows proper release rate for enhanced osseointegration and antibacterial ability. The titanate-NT coating loaded with the proper element has large potential in biomedical applications due to the prevention of implant-associated infection and enhanced osseointegration without the need to apply foreign complex biomolecules. The materials are easy to fabricate and have good stability enabling large-scale industrial production and suitable for storage, transport, sterilization, and clinical use.

DP16  The Effect of PEO Process Parameters on the Tribocorrosion Properties of TiO$_2$ Coatings, E.E. Sukuroglu (eedemirci@atauni.edu.tr), H. Farzi, Atatürk University, Turkey, Süleyman Sukuroğlu, Gümüşhane University, Turkey, Y. Totk, E. Arslan, I. Efeoğlu, Atatürk University, Turkey

TiO$_2$ coatings are suitable materials for use as implants due to their good mechanical properties and their bio-compatibility features. Plasma electrolytic oxidation (PEO) method due to its low cost and ability to achieve high thickness is a proper method for deposition of TiO$_2$ coating. In this study, TiO$_2$ coating was deposited on Ti6Al4V substrates with different voltages and frequencies as the coating process parameters. The mechanical properties of coatings were investigated by scanning electron microscopy (SEM), XRD and EDS analysis. Tribocorrosion behavior of the coating was also measured.