Coatings for Biomedical and Healthcare Applications
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DP-2 Ti-Nb COATINGS Deposited on AISI 316L Stainless Steel by Magnetron Sputtering for Biomedical Applications*, E Gonzalez, D Tallarico,* Federal University of Sao Carlos, Brazil*; A Gobbi,* Brazilian Center for Research in Energy and Materials, Brazil*; C Afonso, **Pedro Nascente**,* Federal University of Sao Carlos, Brazil

AISI 316L stainless steel (SS) and Cr-Co alloys are commonly used for manufacturing biomedical implants due to their reasonably adequate bulk properties. Titanium and its alloys are more biocompatible, but also significantly more expensive, than SS and Co-Cr alloys. Ti-based alloys have and additional advantage compared to SS and Co-Cr alloys: their elastic modulus values are more compatible with those of the human bones (10-40 GPa). The elastic modulus values for AISI 316L, Cr-Co alloys, and pure titanium are 190 GPa, 210-253 GPa, and 105 GPa, respectively The β-Ti (body cubic centered structure) alloys can have an elastic modulus even lower than 55 GPa. Niobium has been used as a nontoxic β-stabilizing agent, and its addition to Ti causes a decrease in the elastic modulus. An interesting option would be to coat an implant with a Ti-Nb thin film having adequate composition and thickness so that the coating would enhance the material biocompatibility. Care should be taken about the corrosion products of the biocompatible β-Ti-Nb coatings, since the implant devices are subjected to harsh environments into the human body and can deteriorate, affecting their service live and releasing potentially harmful particles generated by the corrosion processes which may affect the cell metabolism. Thus, the comprehension of the corrosion and osteointegration processes that occur on the metallic biomaterial surfaces is very important. In this work, β-Ti-Nb coatings were deposited on AISI 316L SS substrate by magnetron sputtering, and then were characterized by atomic force microscopy (AFM), scanning electron microscopy SEM), energy-dispersive X-ray spectroscopy (EDS), transmission electron microscopy (TEM), and X-ray photoelectron spectroscopy (XPS) . Four compositions were produced: 15, 20, 30, and 40 at.% Nb. The addition of Nb in the coatings affected their growth modes. The elastic modulus and the hardness values were in the ranges of 91.8-95.4 GPa and 5.4-7.4 GPa, respectively. The surface oxide layers were constituted of mainly titanium oxides and, to a lesser extent, niobium oxides. These partially oxidized surface layers are highly desirable for implant materials since they provide higher corrosion protection.

DP-4 Investigation of High Performance Hydroxylapatite Coated PEEK Composite Materials for Biomedical Applications*, J Su,* Chang Gung Memorial Hospital, Taiwan*; C Chen, **Gwomei Wu**,* Chang Gung University, Taiwan

Abstract In orthopedic surgery related to trauma or disease, it often requires the use of artificial bone plate to hold the fractured bones to effectively heal the fracture of a long bone. During surgery and postoperative healing period, the antibiotic management is critical to patients with infection control. A wound healing is also promoted by osteointegration and bone regeneration. A proper system needs to be effective to treat the wound, to reduce pain, and to restore function of a healthy life. High performance polyetheretherketone (PEEK) biomedical composites have been investigated for bone plate applications. By appropriate design, the biomedical composite materials can match the different parts of human body bones, quite helpful for long-term functional rehabilitation after surgery. They also remain x-ray transparency, making it easier for clinicians to assess the healing process. We have been developing PEEK composites with biodegradable polylactic-co-glycolic acid (PLGA) double layer structure bone plates and hydroxylapatite (HA) to promote bone regeneration and to derive antibiotic applications. In this report, the analysis of the material characteristics, in-vitro tests, and comparison with literature data will be presented and further discussed. A good understanding in the structure-property relationship would provide better guidelines for implant designs.

DP-5 Structural and Morphological Properties of PEO Films Grown on Ti-10Nb and Ti-20Nb and their Cellular Viability*, **Carlos Lepienski**,* Universidade Tecnológica Federal do Paraná, Brazil*; A Luz,* UFPR, Brazil*; N Kuromoto,* Universidade Federal do Paraná, Brazil*; G Lima,* Athlone Institute of Technology, Ireland*; B Pereira,* Universidade Federal do Paraná, Brazil*; M Sá, D Lima,* Universidade Federal de Campina Grande, Brazil

Recent investigations have been focused on β type titanium alloys as they present biocompatibility, non-toxicity, improved mechanical properties and also exhibit corrosion resistance. These novel alloys are bioinert, consequently surface modifications are required to improve its bioactivity. Plasma Electrolytic Oxidation (PEO) can be employed to produce a porous film which contains oxides of elements that compound the titanium alloys, that is known to exhibit good bioactivity and biocompatibility. With the continuous interest in titanium alloys, the purpose of this study was to modify two different titanium-niobium surfaces via PEO and understand the structure of these films while also analyzing the improvement in bioactivity via cellular viability. Ti-10Nb and Ti-20Nb alloys were treated by PEO under 250 V in 1mol.l^{-1} H_3PO_4 electrolyte during 60 s. For the samples characterization we perform metallographic analysis, X-ray diffraction, Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS), Nanoindentation technique, and cellular viability tests with MC3T3 cells with further analysis on SEM to understand the cellular behavior with the titanium implants. Metallographic analysis and X-ray patterns showed that Ti-10Nb and Ti-20Nb are composed by (α+ β) which were due to the process performed above the β transus temperature to a (α+ β) region, and the slow rate of cooling during the manufacturing process. Nanoindentation testes revealed that Ti-20Nb alloys exhibited the highest value to hardness,(3.0 ± 0.2) GPa, and the lowest elastic modulus, 98 ± 2 GPa. Using the 3D view of SEM technique, Ti-Nb coatings presented important values of roughness with round porous and random diameters. In addition, these images presented values of tickness from ~1.7 µm for Ti-10Nb and 1.0 µm for Ti-20Nb. Due to the electrolyte used, the presence of phosphorous compound which was incorporated into the coating during the PEO process was detected by the EDS spectra. X-ray patterns exhibited a highly crystalline film on Ti-10 Nb alloy which was also observed in great intensity with Raman spectroscopy with anatase phase. Conversely, Ti-20Nb presented a highly amorphous film with a decrease amount of bands of anatase phase observed by Raman spectroscopy. Cellular viability with MC3T3 cells showed no signs of cytotoxicity of these alloys with values higher than the control sample (>70%) but no significant differences were observed between these alloys; although TiNb10% presented mean higher values. These cells attached, differentiated and proliferated well in these alloys due to the porosity, roughness and the elements presented in the film.

DP-6 Tribocorrosion Behavior of SiC Films with and without TiO_2 Nanoparticles on AISI 316L for Prosthesis Application*, A Vieira, T Santos,* Univap, Brazil*; P Radi,* ITA, Brazil*; S Silva,* IEAv, Brazil*; A da Silva,* Univap, Brazil*; G de Vasconcelos,* IEAv, Brazil*; **Marco A. Ramirez R.**,* Universidade do Vale do Paraíba (UNIVAP), Brazil*; L Vieira,* Univap, Brazil

Stainless steel (AISI) materials have an important role in the manufacture of many devices subjected to the corrosive environment including implants. It occurs due to their higher mechanical strength, hardness, and resistance to wear. Regards to the AISI 316L, it is one of the most used implanted material due to its mechanical properties and low cost. However, many papers have been reporting its tribocorrosion and the needing of replacement before ten years. The deposition of Silicon Carbide (SiC) coatings is a cheap strategy to improve its lifetime in corrosive environments due to its properties such as high hardness, biocompatibility, and resistance to corrosion. Additionally, TiO_2 nanoparticles can be incorporated into the SiC films to improve its corrosion resistance.

This paper show was investigated the effect TiO_2 nanoparticles of SiC film on chemical structure, the film morphology, and tribocorrosion behavior in Ringer's solution. The AISI 316L substrates were covered with SiC films with and without TiO_2 nanoparticles using Laser Cladding technique. The laser cladding provides a fast and cheap way to modify the material surface. The mechanical and structural properties of the SiC films were evaluated according to the power and speed parameters of the laser. The tribocorrosion were performed using open circuit potential (OCP) performed in three steps: Static, reciprocating, and static modes with an exposed area of 1.5 cm^2 with 5N force and 5 mm/s sliding speed using an alumina ball as the counter body. The corrosion rate was lower for both films when compared with bare AISI 316L. The best tribocorrosion resistance result was achieved for SiC film+TiO_2 mixture.

Author Index

Bold page numbers indicate presenter