Structure and Composition of Titanium Oxide formed by Oxygen Plasma Immersion Ion Implantation into Titanium

K. Voigl, W. Ensinger, Philipps-University of Marburg, Materials Science Center, 35032 Marburg, Germany

Titanium and its alloys such as Ti6Al4V are known for their favourable mechanical and chemical properties. Since both materials exhibit poor tribological properties, surface treatment may be required for a sufficient tribological performance. In the majority of the studies, titanium and Ti6Al4V have been treated with a nitrogen plasma. The present contribution deals with oxygen plasma immersion ion implantation in order to form protective oxide surface layers. The oxide formation has been investigated for dependence on the ion density of the plasma, pulse repetition rate and pulse number, corresponding to process time. Sets of samples have been prepared at different implantation temperatures. The composition of the modified surface layer has been examined by X-ray photoelectron spectrometry. At low temperature, the amount of incorporated oxygen and its depth distribution is determined by ion-solid-interactions. With increasing temperature the oxygen distribution was determined by both implantation and diffusion. Phase characterization assessed by cross-section transmission electron microscopy showed that the oxide phases formed were α-TiO and rutile TiO₂, depending on pulse number and temperature.

Corrosion Resistance of TiN and TiO₂/TiN Films Deposited on Titanium and Stainless Steel using PIII-D

G.J. Wan¹, N. Huang¹, Y. X. Leng¹, H. Sun¹, P. Yang², J.Y. Chen³, Ji. Wang³, Y. Leng³, and P.K. Chu³, ¹Institute of Surface Engineering of Biomaterials, Dept. of Materials Engineering, Southwest Jiaotong University, Chengdu, 610031, Sichuan, China, ²Department of Mechanical Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China, ³Dept. of Physics and Materials Science, City University of Hong Kong, 83 Tat Chee Avenue, Kowloon, Hong Kong, China

The corrosion resistance of TiN and TiO₂/TiN films fabricated on titanium and stainless steel biomaterials using plasma immersion ion implantation - deposition (PIII-D) are investigated. The open-circuit potential versus exposure time trend andodic polarization curves, and electrochemical impedance spectroscopy (EIS) spectra are obtained. Moreover, the equivalent circuits of the deposited films in physiological saline are employed to interpret the anti-corrosion results. Compared with uncoated titanium and stainless steel higher corrosion resistance and corrosion potentials (Ecorr) are observed from the TiN and TiO₂/TiN films. The EIS equivalent circuit plots show that typical barrier-type films exist on the TiN and TiO₂/TiN coated samples further isolating the solution from the metal substrate. The adhesion strength of the films is evaluated by nanoscratch experiments. As the PIII-D process produces high quality films using filtered metal arc and pulse synchronization nanoparticles can be eliminated completely and good adhesion between the film and substrate can be obtained. Our results indicate that the high corrosion resistance of TiN or TiO₂/TiN coated titanium and stainless steel is due to a low defect concentration and higher film density, thereby slowing the mass transport process across the film and lowering the metal substrate dissolution currents.