Effect of anodizing conditions on the micro-structure and corrosion resistance of commercially pure Ti and Ti6Al4V alloy

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Titanium and its alloys have become the biomaterial of choice for orthopaedic applications due to their overall inertness and non-toxicity when compared with also commonly used Co-Cr alloys and 316L stainless steel and good osteointegration capacity. Commercially pure Ti and Ti6Al4V are the preferred materials for many orthopaedic applications. However, Al and V are released from the alloy inside the body and even small amounts of these ions may cause local irritation of the tissues surrounding the implant.

On the other hand, the introduction of an implant in the body is always associated with the risk of microbial infection, particularly for the fixation of open-fractured bones and joint-revision surgeries. Although the estimated risk of infection for an implanted device is very low, it constitutes one of the main causes for implant loosening in arthoplasty. The bacteria adhesion mechanisms that are very similar to those of the host osteogenic cells. As a result, once an implant is inserted, the occurrence of infection is dependent on the relative speed by which osteogenic cells and bacterial cells adhere to the implant surface. Cell and tissue responses are affected not only by the chemical properties of the implant surface, but also from the surface topography and roughness.

Specific surface treatments which should favor the osteointegration and at the same time discourage the bacterial adhesion without lowering the good corrosion properties of the Ti alloys are required. The anodization of Ti and the formation of TiO_2 nanotubes on the surface of Ti implants is cheap method which can lead to an increase of the surface roughness and can positively influence the osteointegration. Combined with post anodization annealing or by drug loading the nanotubes porosity could also hinder the bacteria adhesion.

The present work focusses on the effect of the anodizing parameters such as applied voltage and time to the microstructure and corrosion resistance of the obtained films. Commercially pure Ti and Ti6Al4V plates have been anodized using an ethylene glycol electrolyte containing 0.5wt.% NH_4F and 2.5% V H_2O. The applied voltage varied from 20 to 120V and the anodization time from 30 to 180min. The obtained films have been characterized by SEM and XRD regarding the microstructure and particular attention has been paid on the structure of TiO_2 nanotubes on the α and β phase grains of Ti6Al4V. The anodized specimens have also been tested regarding their corrosion resistance by potrentiodynamic polarization measurements in a phosphate-buffered saline solution simulating the body fluids.