Production and Characterization of nanotubes on Titanium Alloy Ti6Al4V surface

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Considering their very interesting properties titanium alloys as Ti6Al46V, are used in different applications, as in the field of biomaterials or in corrosive environments. Several studies focused to modify the characteristics of the surface, to improve the compatibility with the human body, or to increase the corrosion and/or tribological behaviour.

In this work, nanotubes were first produced by electrochemical techniques followed by either heat treatments or electrochemical oxidation. The aim is to obtain a compact layer induced by annealing or anodization to guarantee a very good corrosion behaviour and in the same time to improve the reactive area for interaction with the human body by nanostructuration.

Nanotubes were produced using two different non- aqueous baths, one based on glycerol and the second on ethylene glycol. Thermal treatment in air for 3 hours at 450°C or an electrochemical oxidation for 3 hours at 1 V were used to obtain the compact layer. The studied samples are the combinations obtain by these treatments. After microstructural analysis made using optical and electronic microscopes, electrochemical characterisation was obtained with polarisation curves and electrochemical impedance spectroscopy measurements. A Dulbeccos Phosphate Buffered Saline, with MgCl and CaCl at 37°C was used as testing solution. Osseointegration properties were related to hydrophobicity properties studied by water contact angle measurements.

Two phases (namely a and b phases) composed the alloy. The b phase enriched in vanadium appears to have a worse influence on the nanotubes array homogeneity and presents a decrease in thickness.

Among all the samples, the dual treated ones with a compact layer combined with a porous layer from glycerol bath, show the best solution for a good osseointegration and at the same time a good corrosion resistance, despite the poor adhesion of nanotubes. Through the corrosion tests as open circuit potential, electrochemical impedance spectroscopy and cyclic polarization, a reduction of passivation current density and an increase of impedance at low frequency for anodized surfaces and for surfaces with porous and compact layers, has been noticed with the increase of immersion time in working solution.

The various tests show that the non-homogeneity of the layers significantly influences the final corrosion resistance properties due to the pitting formation.