Effect of added porosity on a novel porous Ti-Nb-Ta-Fe-Mn alloy exposed to simulated body fluid

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Porous titanium materials have gained interest as prosthesis materials due to their similar mechanical properties to the human bone, biocompatibility, and high corrosion resistance. The presence of pores in the metal matrix implies a decrease in the elastic modulus and an increase in the active area, perhaps improving the osseointegration. Corrosion resistance is a critical consideration as corrosion may lead not only to mechanical failure but also the release of ions and/or particles to the bloodstream. In this work, a novel Ti-Nb-Ta-Fe-Mn alloy with varying percentage of porosity (25, 31 and 37 v/v%) was exposed to simulated body fluid (SBF) at 37 °C and its corrosion resistance was investigated using electrochemical techniques and surface analysis as a function of exposure time. Open circuit potential and polarization curves revealed that the effect of porosity was mainly on the shift of the corrosion potential to more negative values with a slight increase in the anodic current. A passive range was also observed, which was not influenced either by increased exposure time or increased porosity. Therefore, a change in the surface specific area could have taken place during the exposure, which is not necessarily related to a corrosion process.

Moreover, a typical porous electrode behavior was identified by electrochemical Impedance spectroscopy, without any significant change over time. No release of metal ions was detected by on line ICP-AES, either at the open circuit potential or upon polarizing the samples up to 2 V vs. SCE, whereas only traces elements (Fe and Mn 1 nmol/s cm2) were detected in the electrolyte accumulating all released ions during 30 days of exposure. Additionally, the surface analysis showed thickening of the oxide layer with exposure time. Therefore, the stability of the passive layer and low release of ions indicate that the porous alloys are suitable for further study as prosthesis materials.

Electrochemical

Joint implants

Porous electrode

Ti-based alloys

Atomic emission spectroscopy

Biocompatibility

Body fluids

Corrosion resistance

Corrosion resistant alloys

Electrochemical corrosion

Electrochemical electrodes

Electrochemical impedance spectroscopy

Electrolytes

Failure (mechanical)

Iron alloys

Metal implants

Metal ions

Metals

Niobium alloys

Porosity

Prosthetics

Surface analysis

Tantalum alloys

Titanium alloys

Corrosion potentials

Electrochemical

Electrochemical techniques

Joint implants

Open circuit potential

Porous electrodes

Simulated body fluids

Ti based alloy

Manganese alloys