

Abstract

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Title: Corrosion of Biocompatible Titanium-alloys
(Korrosion biokompatibler Titan-Legierungen)

In comparison to titanium cp2 corrosion of the technical, biocompatible β -titanium alloys Ti-45Nb and Ti-35Zr-10Nb, TiadyneTM 3510, is observed in phosphate buffered saline solution, PBS, with and without physiological hydrogen peroxide addition.

In the current study immersion tests as well as potentiodynamic DC-polarization, Mott-Schottky-tests (AC) and electrochemical impedance spectroscopy, EIS, with simulation of the semi-conducting oxide-layers are performed.

Except of bioadhesion of zirconium, all alloys are biocompatible. The high corrosion resistance with low interaction with human cell membranes is caused by a nanostructured system of two oxide-layers.

Regarding corrosion susceptibility the β -phase is comparable to α -phase. But the amount of alloying elements leads to different diffusion-dense layer structure, building-up an inner, non-ideal layer (regarding electrical properties) and an outer, ideal capacitor oxide-layer. Resistance is caused by separation of charge in the inner layer working as barrier or which is conducting.

The hydrogen peroxide in physiological concentration increases corrosion because of decreased hydrogen overpotential. Due to decrease of the negative charge at the surface and in the following in the layer system, layer-build-up is fastened.

All alloys show crevice corrosion. Moreover the Ti-35Zr-10Nb fails by intergranular corrosion.

Compared with Nb₂O₅ and ZrO₂ the smaller band gap of the TiO₂ on α -titanium reduces susceptibility against outer potential shifts. In spite of higher sensitivity against first potential shifts for both β -alloys, the Ti-45Nb shows failures only at higher shifts of steady-state. Due to TiO₂-enrichment in the inner layer and Nb₂O₅-enrichment in the outer capacitor layer diffusion is reduced. By this, regarding system shifts, most robust alloy is the Ti-45Nb. Zirconium content in Ti-35Zr-10Nb leads to a more electron-dense layer, while it is more susceptible against system shifts because of the energy which cannot be used for electron activation to the conduction-band.