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ROZPRAWA DOKTORSKA

Nanotubularne warstwy tlenkowe na stopie Ti6Al4V jako matryce elektrochemicznego biosensora

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Abstract

Nanotubular oxide layer on the Ti6Al4V alloy as a matrix for electrochemical biosensor

The work presents a novel application of anodically formed nanotubular oxide layer on the Ti6Al4V alloy. The results confirm that this nanotubular oxide layer, made of vanadium, titanium and aluminum oxides enables quick and reliable electrochemical detection of bone alkaline phosphatase within 1-10 ng/ml concentration. To prepare the biosensor electrode based on the Ti6Al4V alloy, the optimalization of anodizing process, and the explanation of the influence of electrolyte composition on nanotubular oxide layer morphology, was required. Uniform nanotubular oxide layer with nanotubes of 50 nm diameter and 1μm thickness on the Ti6Al4V alloy was obtained in ethylene glycol electrolyte with 1% wt. of H_2O and 0.6% wt. NH_4F by anodizing at 22V for 20 min. To increase electrical conductivity of nanotubular oxide layer containing TiO_2, Al_2O_3, VO_2 and V_2O_5, the thermal modification was carried out at 600˚C for 2 h in argon, nitrogen or air. Vanadium diffusion through nanotubular oxides upon both phases was observed during heating in nitrogen. The SEM, EDS, XRD, XPS and electrochemical tests of nanotube layers in PBS solution confirmed their unique electrical properties. The nanotubular oxide layer on the Ti6Al4V alloy with 50nm diameter and 1μm thickness after thermal modification in nitrogen and functionalization by bALP antibody revealed to be suitable for the amperometric and impedimetric detection of bALP antigen.