Katedra Materiałów Inżynierskich i Biomedycznych
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ROZPRAWA DOKTORSKA

„Wpływ hybrydowej modyfikacji powierzchni biomateriałów ze stopu tytanu Ti6Al4V na jego własności fizykochemiczne oraz biologiczne”

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2. Abstract

The aim of the work was to develop and investigate the possibility of using a hybrid variant of surface modification of Ti6Al4V titanium alloy, manufactured using the SLM process to obtain biomaterials with favorable biofunctional properties.

Based on the SLM process parameters optimization, it was found that the relative density of the tested samples increased with the increase of the laser energy density (P) and with the decrease of the scanning speed (SP). The samples' relative density was not linearly related to the linear energy density (E) delivered to the powder material. Four SLM process windows were defined based on the degree and nature of the porosity of the samples. The samples manufactured using P = 400 W and SP = 700 mm / s (E = 575 kJ / mm) were characterized by the highest values of the relative density, which correspond to 93.3% of the reference density of the Ti6Al4V alloy. Microscopic analyzes (light microscope, SEM and TEM) of the samples after heat treatment by annealing (T = 800° C, t = 4 h) showed that the structure of the alloy was the equilibrium of phases α + β. The presence of the martensitic α-type phase, characteristic of SLM as-built details, was not revealed.

Based on the physical- and electrochemical properties, a positive effect of ZnO layer deposition on the surface of Ti6Al4V alloy on its corrosion resistance was recorded. In effect, the reduction of substrate material degradation under conditions simulating inflammation was demonstrated.

Additionally, it was found that the surface treatment by laser micro-texturing process provides increased the wear resistance of the substrate material in lubrication conditions. Based on the microbiological tests, it was shown that the samples after laser texturing, and with the ZnO layer were biocompatible with normal fibroblast cells (U2OS) and biocidal properties against
E. coli bacteria in the test after 24 h of incubation. Additionally, the samples showed toxic properties toward neoplastic cells (NHDF).

It was shown that the use of a hybrid variant of the surface modification of the Ti6Al4V alloy, obtained with the SLM technology, made it possible to obtain a biomaterial with physicochemical and tribological properties desired due to the considered application in the human body.