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Tribological behavior of titania coatings produced by micro-arc oxidation method on hydrostatically extruded titanium

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Micro-arc oxidation (MAO) method proved itself very effective in the formation of functional coatings on the surface of titanium-based materials with an intention to be used as the dental implants. A number of methods of plastic deformation of titanium of commercial purity (cp-Ti) allowing to increase its mechanical properties through the grain refinement was developed and hydrostatic extrusion (HE) turned out to be a very promising one. Our recent work confirmed the possibility of covering such substrate with a uniform MAO coating. However, tribological behavior of the MAO coating produced on the surface of the cp-Ti after HE was not investigated so far.

Therefore, in this work, the influence of the plastic deformation of the cp-Ti substrate material on the tribological behavior of titania coating produced on its surface through micro-arc oxidation was investigated. For these studies titanium grade 4 was used as a substrate material. It was subsequently subjected to the multi-pass HE. Next, MAO was carried out in an aqueous solution of disodium hydrogen phosphate (14.4 g/L) with the help of pulsed power supply. Microstructure characterization was conducted with scanning (SEM) and transmission (TEM) electron microscopy by taking advantage of ThermoFisher's Scios 2 Dual Beam and Themis G200 FEG microscopes, respectively. The tribological behavior of the MAO coatings was determined using TriboTechnic reciprocating wear tester.

The results of the SEM/EBSD and TEM microstructure characterization confirmed that the plastic deformation through the HE allowed to decrease the average grain size of cp-Ti from ~50 μm down to ~10 μm. The MAO coating deposited on the HE-processed rod shows a similar microstructure on the cross-sections, both parallel and perpendicular to extrusion direction with higher thickness than that of the as-supplied cp-Ti. The wear tests revealed that the acceleration of the growth of the MAO coating on the fine-grained substrate increases its wear resistance compared to the coarse-grained one.

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