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Morphology and mechanical properties of the nanotubular oxide coating formed on the ultrafine-grained Ti-13Nb-13Zr alloy

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Behaviour of the metallic biomaterials is also regulated by surface properties, which is an important factor in interactions of the implant material with the surrounding tissue. The lower value of modulus of elasticity and closer to that of a bone is one of the crucial surface properties in accepting the implant material from the surrounding tissue, and reduces the possibility of slow disappearance of bone in contact with the implant. In the present study, nanotubular oxide layer on Ti-13Nb-13Zr alloy (coarse-grained (CG), and ultrafine-grained (UFG), obtained by high pressure torsion (HPT)) alloy was formed by means of electrochemical anodization in the 1M H_3PO_4 + NaF electrolyte, during 60 and 90 minutes. The scanning electron microscopy (SEM) was used to characterise the morphology of the surface. It was shown that the nanotubular oxide layer was obtained using the electrochemical anodization process during both anodizing times. The aim of this study was to determine the nanomechanical behaviour of the surface - modulus of elasticity and nanohardness, of the CG Ti-13Nb-13Zr and UFG Ti-13Nb-13Zr alloys before and after electrochemical anodization process, using the nanoindentation technique. The displacements during nanoindentation tests were 2000 nm for non-anodized samples and 10 % of the thickness of nanotubular oxide coating for anodized samples. Loading-displacement curves were obtained during the nanoindentation tests. Each curve consists of the loading part, the dwell period at the maximum load of the indentation and the unloading part and they use for determinate maximum mean values of load on the samples and the presence the surface deformation. Also, in order to characterise deformation of the nanotubes after nanoindentation SEM was done. Obtained results showed that surface of the anodized alloys had lower modulus of elasticity than surface of the non-anodized alloys, which means that the values are closer to those of bones, making the discontinuity of mechanical properties at the bone-implant interface less pronounced. The nanoindentation test showed that surface of the anodized UFG alloy had the lowest modulus of elasticity of the surface than all tested samples, which makes it more acceptable for biomedical usage.