Microstructure and mechanical characterization of thin bioactive PEO coatings fabricated on UFG CP Ti

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Abstract

Plasma Electrolytic Oxidation (PEO) coatings were deposited on Ultra-Fine Grained Commercially Pure Ti (UFG CP Ti). The objective of the deposited coatings is to provide enhanced bioactivity to the protective anodic TiO_2 film by the incorporation of Ca and P ions. Three coatings were deposited under the same processing conditions using three electrolytes containing Ca and P species with different pH levels. All the deposited coatings were characterized by a high surface roughness and high porosity. Nanopores and random-shape micro-cavities were found through their thickness. However, the surface and through-thickness morphologies developed were different from one coating to another. The composition and the phases present were also evaluated by means of EDX and XRD, respectively. The presence and the amount of Ca and P elements depended on the electrolyte. Nanocrystalline TiO_2 anatase and rutile phases were found, being Anatase the predominant phase in all the coatings. The sample corresponding to the lowest pH electrolyte did not present the rutile phase. In the other two samples, rutile had a significant presence in one of the samples while in the other one its contribution was minimal. The mechanical characterization of the coatings was carried out by nanoindentation. This represents a challenge, due to the inherent porosity and large roughness characteristic of PEO coatings. To overcome this challenge, low-depth nanoindentations (~150 nm) were performed on the cross-section of the coatings, and care was taken to minimize the influence of micro-cavities. The correlations between the mechanical properties and the phase composition of the coatings will be presented.

Figures

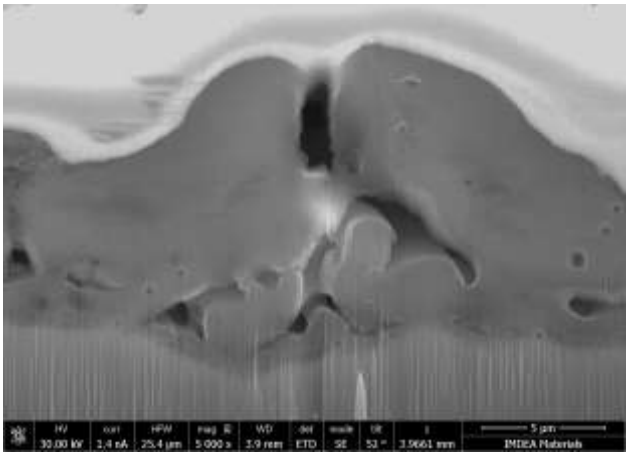

Figure 1: Cross-section of a PEO coating obtained by Focused Ion Beam milling. Thickness between 10-15 µm.

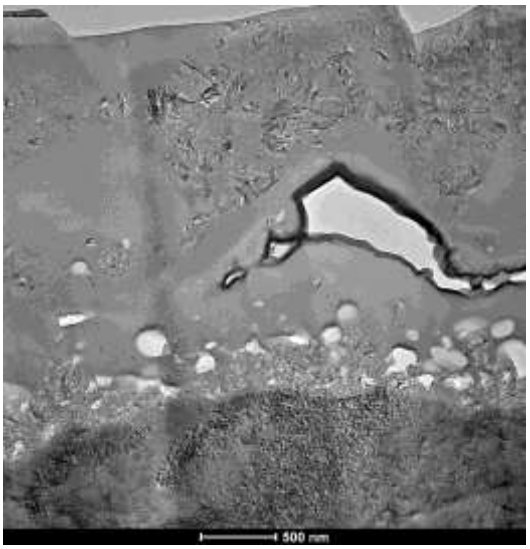

Figure 2: Bright field TEM image of a PEO coating. The figure shows coexistence of both nanocrystalline titania and amorphous Ca/P containing domains