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Nucleation kinectics of the TiO_2 anodic films obtained with sulphuric acid under galvanostatic mode

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Abstract – Nucleation kinetics of TiO_2 anodic films obtained with sulphuric acid were investigated. Commercially pure titanium plates were anodized with an applied current density of 150mA/cm^2 and oxidation time ranging from 10s to 60s. Films properties such as morphology, thickness, roughness and microstructural changes were obtained with scanning electron microscopy, profilometry and X-ray diffraction, respectively. It was observed that the porosity and thickness of the anodic films increase with the anodization time. It was also observed the presence of anatase and rutile phases on the modified surface.

The anodic oxidation is a successful technique used to modify titanium implants surface in order to improve their bioactivity [1]. This technique is strongly dependent on the experimental conditions such as electrolyte's type and concentration, applied voltage and current, time, temperature, etc. In this work we analyzed the nucleation kinetic of the TiO_2 anodic film under galvanostatic mode with anodization time ranging from 10s to 60s. It was used Ti commercially pure plates, 1M H_2SO_4 as electrolyte and Ti as the counter-electrode, with a current density of 150 mA/cm^2. The surface morphology was analyzed by scanning electron microscopy, thickness and roughness by profilometry, and structural changes by X-ray diffraction technique. With the increase of the anodization time it was verified that: (i) the thickness, porosity and roughness of the TiO_2 films increases, as observed in fig. 1 (10s, 30s and 60s); (ii) the anodic film presents both anatase and rutile phases and the quantity of the rutile phase increases (fig.2 – 60s); (iii) there is an abrupt increase in voltage up to 90 V (curve voltage versus anodization time in fig.1) corresponding to the film formation, and then it is observed fluctuations on the voltage corresponding to sparks formation due to dielectric rupture of the film, generating the surface pores. Thus, we were able to produce porous and rough surface and according to literature the modified surface obtained with 60s has a great potential to be bioactive.

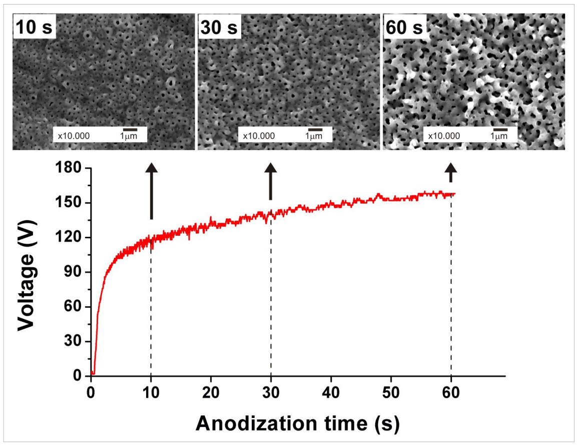

Figure 1: The curve voltage versus anodization time and the morphology presented by the films at the anodization stages 10s, 30s and 60s.

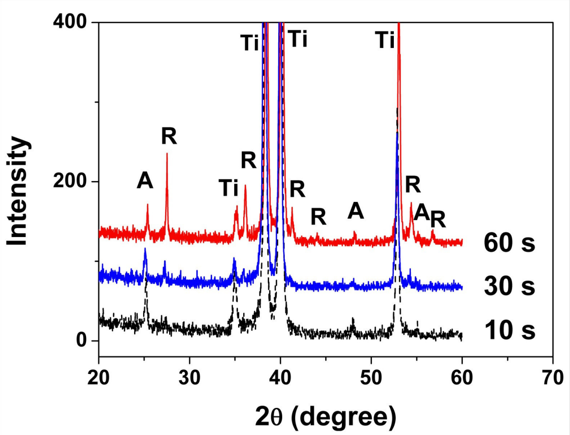

Figure 2: X-ray diffraction patterns for the films obtained at the anodization stages 10s, 30s and 60s. A = anatase; R = rutile; Ti = titanium.

[1] Yang B, Uchida M, Kim H M, Zhang X, Kokubo T., Biomaterials 25 (2004) 1003.