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Surface Characterization of Ti Sand Blasted for Medical Applications

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Abstract – In this work cp-Ti was shot blasted in order to make its surface bioactive and to study its morphology, crystalline phases and nano-scratch properties. For the sand blasting was performed using Al_2O_3 microspheres conducted by an air flow during 6s. According to the SEM images the roughness drastically increases by the sand blasting. In addition, scratch behavior on sand blasted Ti is different from the polished one, since surfaces become harder and presenting some brittleness under scratching loads up to 40gf.

Titanium and its alloys have been widely used for medical applications, however their surfaces are not bioactive. Roughness is an important feature to improve the osseointegration between Ti and living tissues, which can be achieved by means of shot blasting with hard particles [1]. In this work, titanium was shot blasted by alumina microspheres in order to make its surface bioactive and to study the surface morphology, structural changes and nano-scratch properties. Commercially pure titanium samples (grade 2), 2 mm thick, were polished to a mirror-like finishing and washed carefully in an ultrasonic bath using successively acetone, isopropyl alcohol and distilled water. The shot blasting was performed using Al_2O_3 with 280µm average diameter and air pressure of 20 bars during 6 s. Morphological changes were analyzed by a scanning electron microscope (SEM). The crystalline phases were identified by X-ray diffraction (XRD) using CuKa radiation, running at 40 kV and 20 mA in the range $20°\leq 2\theta \leq 60°$. Nanoscratches were performed by a instrumented indentation device with ramping load up to 40 gf, following the edge of the pyramidal diamond tip (Berkovich type). In the XRD results (Fig. 1), Ti peaks became broader after the process due to the produced lattice distortions. Al_2O_3 peaks were identified on the treated samples, indicating that residual alumina remains at the surface. The shot blasting process drastically increased the surface roughness, as can be seen in Fig. 2 and 4. The behavior of the polished Ti surface under scratching is ductile, with removed material piled-up in both sides of the tip track, however the piling up is not observed in the shot blasted surface. In addition, the scars inside the tip track on the shot blasted sample, as well as the track width, are less pronounced than for the polished Ti. The nano-scratch profiles (Fig. 3) show that penetration depth are about 2 µm for both polished and shot blasted Ti, however the elastic recovery after the scratch is smaller for the treated sample. The fluctuations in the shot blasted profiles indicate third body interactions with hard particles. In conclusion, the shot blasting process applied on titanium for medical means become the surfaces rougher, harder and presenting some brittleness under scratching loads up to 40 gf.

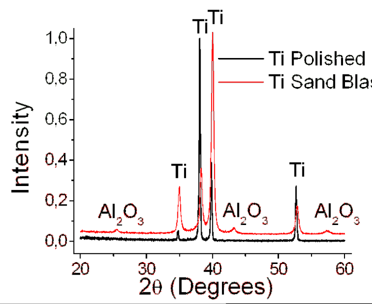

Figure 1: X-ray diffraction patterns.

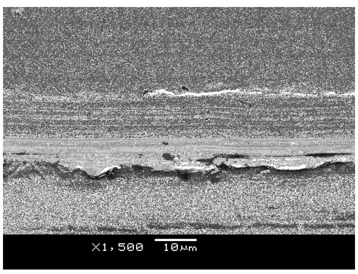

Figure 2: SEM image (1500X). Nano scratch on polished Ti.

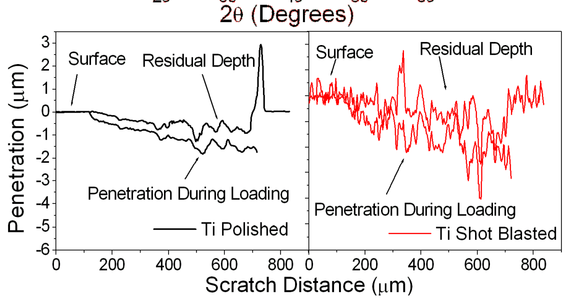

Figure 3: Nano scratch profile: polished and shot blasted Ti.

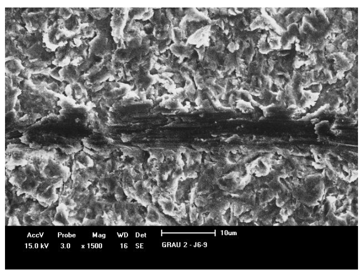

Figure 4: SEM image (1500X). Nano scratch on shot blasted Ti.

[1] C Aparicio, F.J. Gil, C. Fonseca, M. Barbosa and J.A. Planell, Biomaterials. 24 (2003) 263-273.