Surface modification of Ti6Al4V alloy by pulsed lasers: microstructure and hydrophobic behavior

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In many aerospace applications, it is important to produce hydro-repellent surfaces because water and ice accumulation could lead to malfunctioning of the part or component with a potential critical failure. In this study, it was investigated the microtexturing of a titanium alloy (Ti6Al4V) by applying a pulsed Nd:YAG laser, aimed at the surface characterization by microscopy, X-ray diffraction, roughness tests and nano-indentation tests as well as free fall drop test. The experimental procedure aimed to understand the influence of three variables: (N) the number of laser runs 1, 2, 5 and 10; (V) laser speeds of 25, 50 and 100 cm/s and (P) laser power of 5, 10 and 20 W on the microstructure and the hydrophobic behavior. The Vickers hardnesses of laser processed surfaces were slightly higher than untreated surfaces, i.e. 420±10 HV compared to 350±10 HV, because of the oxygen enrichment of α-phase. According to the X-ray diffractometry, more accumulated laser energy lead to a wider α-hexagonal cell, corroborating the hardness measurements. When the number of the laser runs (N) increased, a thicker Hongquiite (TiO) phase could be observed by microscopy and estimated by X-ray diffraction. The measured roughnesses increased with increasing P and decreasing V, showing the relevance of the laser shot energy. However, as the number of runs (N) increases the surface became more and more flat, consequently the overlapping runs induced polishing of the titanium surfaces. For example, the mean roughness Ra attained 0.23 µm after 10 runs at V=100m/s and P=10W, compared to Ra=0.41 µm of the virgin surface. Concerning the hydrophobic behavior, the best results were scattered amongst different conditions N-V-P. However, the surfaces produced when N=1, P=5W and V=50 cm/s or V=100 cm/s were distinctly superior for repelling water drops.