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TRIB / Plasma - deposited protective and tribological coatings

Resonant nuclear reaction analysis investigation of nitrogen and oxygen diffusion processes involved in plasma assisted multi-interstitials surface hardening of Ti6Al4V alloy

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Abstract content

Widely employed in industrial applications including aeronautics turbines and biomedical prosthesis, titanium alloys are presenting highly interesting properties, like low density, high strength or excellent oxidation or corrosion resistance. However, their uses are often restricted by their poor tribological behaviour. Hence, several treatments are proposed to improve the wear resistance, for instance by depositing a hard surface layer (like titanium nitrides or carbides). Without any substrate preparation, these hard and often fragile layers may lead to the "eggshell" effect when the wear solicitation is important and the damages induced by the wear debris on the "soft" substrate may be worse than with untreated titanium alloys. In order to remedy this weakness, multi-interstitials (N, O) diffusion surface treatments of the titanium alloy substrate can provide a thick and strong mechanical support to the top hard layer or can directly be the wear resistant layer. For this purpose, low-pressure plasma assisted diffusion thermochemical treatments, using sequential Oxygen and Nitrogen atmosphere, were applied on Ti6Al4V samples: nitriding was operated at 850°C and working pressure of 5 Pa (60%vol. N_2 + 40%vol. H_2); oxidations were operated at 750°C and working pressure of 5 Pa (100% O_2 or 100% CO_2).. In order to study the potential influence of each interstitial (N, O) on the diffusion of the other one, various sequential treatments (nitriding + oxidizing or oxidizing + nitriding) were performed with isotopic ^{15}N or ^{18}O elements in the reactive atmosphere and the resulting composition profiles were analysed by resonant nuclear reaction analysis (NRA). Microstructure of the modified surfaces were also characterized by optical microscopy and scanning electron microscopy (SEM) and the crystallographic structure was determined by X-Ray Diffraction (XRD); Glow Discharge Optical Emission Spectroscopy (GDOES) and Energy Dispersive X-Ray Spectroscopy (EDS) provided depth profiles of the treated surface chemical composition and were compared to the NRA results. To investigate the potential improvement in wear resistance, Vickers microhardness profiles were measured on cross section. Improved microhardness profiles were obtained over few tens of micrometres by combining nitriding + oxidizing treatments of few hours, corresponding to incorporation of O and N interstitials in the α-Ti matrix.

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References

M. Drouet, L. Pichon, J.B. Dubois, E. Le Bourhis, T. L. Christiansen, 14th world conference on Titanium, June 10-14 2019; Nantes; France