Master 2 internship

Year 2020-21

Multi-interstitials compounds: a new way in surface properties optimization of Titanium alloys

Supervisor(s)	PICHON Luc	DROUET Michel	
Research team(s)	Pprime / SIMAC	Pprime / SIMAC	
Partner (indust. or académic)	oui	DTU Danemark	
Possibility of PhD ?	Yes if Financial support completed		
Financement thèse	½ Labex + ½ to be found		
Key words	interstitials	titanium	diffusion
	micro/nanohardness	Plasma treatments	

Titanium alloys are widely employed in numbers of industrial applications, like aeronautics, requiring high mechanical strength / mass ratio. The native surface oxide make them highly employed in chemical industry where corrosion resistance is of importance. Moreover the biocompatibility of titanium alloys has dedicated them to bone prosthesis. However, their wear properties remain to be improved, which up to now highly limits their use in more applications. Surface thermochemical treatments of metallic alloys have already shown their capability to answer to such issue. In collaboration with Danish Technological University (DTU), a multi-interstitial surface treatment, based on simultaneously or sequentially Nitrogen, Oxygen and/or Carbon incorporation in Ti alloys, process is developed in P' Institute. Using this treatment, significant improvements of hardness can be obtained over depth of industrial interest (a few 10s to 100s µm). The involved diffusion and the hardening mechanisms remains however not well understood. This study is then aiming to determine the relations between the interstitials contents and the hardness and the coupling between the different species diffusion. Moreover, keeping after the surface treatment the mechanical bulk properties of the Ti alloys is of primary importance: in addition to the hardness modification, the traction behaviour and fatigue lifetime will be investigated.

The proposed internship will focus on the determination of the diffusion parameters involved in the treatment of (pure) Titanium and the TA6V alloy. Oxi-nitriding treatments with gas enriched with ^{18}O and ^{15}N isotopes will be operated the plasma assisted thermochemical treatment reactor of the Physics and Mechanics Department (DPMM) of the P' Institute (see DPMM-SIMAC team: https://pprime.fr/?q=fr/recherche-scientifique/d1). Microstructure of the modified surface will be characterized by optical microscopy and scanning electron

microscopy (SEM). The crystallographic structure will be determined by X-Ray Diffraction (XRD); Glow Discharge Optical Emission Spectroscopy (GDOES) and Energy Dispersive X-Ray Spectroscopy (EDS) will provide depth profiles of the treated surface chemical composition. Hardness will be studied by Vickers micro-indentation and/or nanoindentation. Resonant Nuclear Reaction Analysis (NRA) will enable the characterization of the isotopes profiles of the dedicated samples and the determination of the diffusion mechanisms.

A Master (M2) student or Engineer student (3rd year) with motivation and skills in experimental characterization of materials and surfaces is expected for a 5 to 6 months internship (feb – sept 2021). This work will likely be pursued by a 3 year PhD open position (to be confirmed).

Grant :

570 € / month

Application to the INTREE program (grant + travel support) possible for students from foreign universities (dead line January 31st; 2021).

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