Comparison of surface patterning realized with and without ion bombardment on steels

Aurore Andrieux[1], Borges Ramos Bruno[1], Marcos Grégory[1], and Thierry Czerwiec*†[1]

[1]Institut Jean Lamour – Institut Jean Lamour – France

Abstract

Low-temperature thermochemical plasma-assisted treatments are commonly used on austenitic stainless steel to enhance surface properties by forming an enriched surface layer.
During a nitriding treatment a large amount of nitrogen is introduced in the austenite lattice, inducing high compressive residual stresses. As a result, an expansion of the treated layer from the initial position of the substrate in a direction perpendicular to the surface occurs.

We take advantage of this phenomenon, called uplift, to create a pattern on the surface. The idea is to protect locally the surface by covering it with an appropriate masking technique. By doing so, only the uncovered parts will be exposed to the incident plasma. After nitriding the surface presents a controlled topography, due to the difference of height induced by the spatially restricted uplift.

This technique was initially applied on stainless steel [1] using a multi-dipolar plasma, based on the Distributed Electron Cyclotron Resonance concept, belonging to the new generation of low-pressure, high-density plasma sources providing independent substrate biasing and independent

ion flux and ion energy control. The resulting plasma diffuses towards the substrate-holder that can be independently heated and/or biased. It is thus possible to carefully control the sputtering of the sample surface. In this communication, we will compare the results obtained using the multi-dipolar plasma to the one obtained using a conventional ion nitriding device. For that purpose, stainless steel and ferritic steels will be used.

We conduct SEM, XRD and GD-OES analyses to determine surface layer characteristics and tactile profilometry to measure pattern dimensions.

This work is financially supported by the French National Research Agency (reference ANR 2011 RMNP 008 01).
Czerwiec,T., He,H., Marcos, G., Thiriet,T.,Weber, S., Michel,H.. Fundamental and innovations in plasma assisted diffusion of nitrogen and carbon in austenitic stainless steels and related alloys, Plasma Process. Polym. 6, 401, 2009

Keywords: nitriding, patterning, plasma, steel

*Speaker
†Corresponding author: thierry.czerwiec@ijl.nancy-universite.fr