PO2066

On the origin of the high time constant for reaching stationary superficial nitrogen content in plasma diffusion treatments of austenitic stainless steel

Gregory MARCOS, Aurore Andrieux, Thierry Czerwiec

Institut Jean Lamour, NANCY, France

gregory.marcos@univ-lorraine.fr

Plasma-assisted diffusion treatments are widely used in manufacturing for surface hardening of ferrous and no ferrous materials. In particular, tribological properties of austenitic stainless steels (AAS) are improved by the formation of the so-called expanded austenite containing large amount of nitrogen or carbon. Depending on the conditions, it is commonly observed that the superficial content in nitrogen or carbon reaches a stationary value only for long times (some hours) during plasma assisted diffusion treatments. This phenomenon is difficult to observe during plasma assisted nitriding of ferritic steels due to the formation of iron nitrides with well defined composition. Low temperature nitriding of AAS offers the chance to reach a very wide range of superficial nitrogen content.
In this communication, we will present and compare the time evolution of the superficial content in interstitial elements for different plasma assisted diffusion treatments: nitriding, carburizing and nitrocarburizing. These treatments were performed on AISI 316L in a distributed electron cyclotron resonance plasma reactor. In such a system, the sample holder can be independently heated and biased and so sputtering due to ion bombardment of the surface is limited. The interstitial element contents are measured by Glow Discharge Optical Emission Spectroscopy.
For nitriding, the nitrogen superficial content exponentially increases to reach a stationary value at 9 h of treatment. This behaviour is modelled by using gain and loss terms source. Diffusion and recombination of nitrogen atoms on the surfaces are taken into account to describe the observed exponential law. Such non constant superficial nitrogen content has important consequences on the nitrogen distribution in the depth of the nitrided layer. For carburizing, carbides formation occurs very early in the process and the superficial carbon content can be considered as constant. For nitrocarburizing, the nitrogen superficial content also increases slowly with the treatment time, but the range of variation is much lower as compared to nitriding. Finally, a discussion on the role of different surface mechanisms will be given in order to optimize this kind of process.

Keywords
nitriding