KN1100

The role of noble gases ion bombardment (atomic attrition) on plasma nitriding processes

Fernando Alvarez[1], E.A. Ochoa[2]

[1]Instituto de Fisica-UNICAMP, Campinas, Brazil [2]Instituo de Fisica-Unicamp, Campinas, Sao Paulo, Brazil

alvarez@ifi.unicamp.br

Plasma nitriding relies on nitrogen ion implantation and thermal diffusion. The process can span from few hours up to days. Diminishing the relative long processing times is a challenge to increase the efficiency of the technique. For a fixed process temperature, the nitriding efficiency depends basically on nitrogen bulk diffusion and surface properties. On one hand, nitrogen bulk diffusion mechanisms are determined by the material characteristics. On the other hand the whole efficiency of the process strongly dependent on the condition of the surface. Ex situ treatments such as mechanical attrition produced by shot penning, sandblasting, and ball milling are macroscopic methods addressed to modify the surface and improve nitriding efficiency. In situ surface atomic attrition by noble gases bombarding is an alternative route for surface modifications at nanoscopic scales. Indeed, Ar^+ sputtering is currently applied to eliminate oxides and residues that jeopardize nitriding efficiency. However, the physical consequences of the atomic attrition are more intriguing that a simple cleaning effect. Indeed, increasing nitrogen diffusion path by nanoscopic grain refining, defects, stress, and non linear elemental vibrations excitations are some of the reasons invoked to explain nitriding enhancing in metal pretreated and post treated ion bombarded substrates. In this presentation we shall discuss the effect on nitrogen diffusion in steel due to atomic attrition pretreatment by employing Xe^+, Kr^+, Ar^+ ions of relative low energy (50 - 350 eV). The electron core levels energies of the trapped noble gases are strongly modified by the surrounding atoms, as reveled by experimental and theoretical XPS studies. Low angle x-ray diffraction shows the evolution of the stress due to the noble gases atomic attrition. Nano-hardness measurements show the effect of the ion bombardment on the material surface before and after nitriding. Temperature effusion studies of the implanted ions are used to elucidate the noble gases site localization in the network and the influence of the projectile size on the studied phenomena discussed. Finally, it is shown that the atomic attrition pretreatment increases the N diffusion coefficient.

Keywords
Plasma Nitriding