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Tribocorrosion of High Nitrogen 15-5PH Stainless Steel Obtained by Plasma Nitriding and Solution Heat Treatments

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Abstract – High Nitrogen 15-5PH stainless steel was obtained by Plasma Nitriding and subsequent furnace Solution Heat Treatments (PNSHT), at different temperatures. The influence of the solution heat treatment on the dissolution process of nitrided layer has been considered. The microstructure, hardness and tribocorrosion behavior in 3,5% NaCl, were studied. High nitrogen austenitic cases can be obtained after PNSHT of martensitic precipitation-hardened steel (15-5PH). Despite the lower hardness of austenite phase comparatively to the martensite phase present in the substrate, the tribocorrosion resistance was increased in specimens PNSHT.

Properties and manufacturing methods of high nitrogen stainless steels has been gaining interest in the recent growing literature. The nitrogen has a great influence on the properties of stainless steel. Some of them are: high strength, ductility, work hardening, toughness, good corrosion resistance and reduced tendency to grain boundary sensitization [1]. These properties are of great interest for chemical, aerospace and nuclear industries as well as a special interest regarding sea water systems. Besides, Nitrogen is a strong austenite stabilizer which may promote the stabilization of austenite surface layer in martensitic stainless steel or martensite surface layer in ferritic stainless steel [2]. Many processes were developed with the objective to introduce Nitrogen and consequently increased corrosion resistance and mechanical properties of stainless steels. The most common was DC plasma nitriding in low temperature [3] and ion implantation [4]. The Ion Implantation and low temperature plasma nitriding can produce higher nitrogen content on coating layer, usually between 10 to 20%wt and the layer thickness was about few microns for Ion Implantation process and up to tens of micrometers for the samples plasma nitriding at about 400°C. Moreover High Temperature Gas Nitriding can produce thickness layer about 1mm and nitrogen content less than 1.2%wt. In the present study, a PNSHT was applied to enhance the tribocorrosion properties of the 15-5PH stainless steel. Were studied layers produced by Plasma Nitriding (PN) at 520ºC and solution Heat Treatments (SHT) at 1100, 1200 and 1275ºC (F521, F522, F523 respectively). Fig. 1 is shows the schematic representation of the PNSHT thermal cycle. Tribocorrosion tests were carried out in a pin-on-plate geometry using an alumina ball (∅3 mm). The displacement amplitude was 4 mm and the normal load was 5, 20 and 35N. Fig. 2 presents the microstructure and hardness profile of samples SHT at 1100ºC (F521). The nitrogen content on PNSHT surface layer changed surface of the samples. The microstructure consists of a porous surface layer, on top of austenite layer and finally a martensitic region. The hardness on austenite phase region was between 230 and 270HV. The nitrogen content on surface layer was estimated to be higher than 0.52%. The thickness of austenite is 300, 320 and 430µm for samples F521, F522 and F523, respectively. The martensite present beneath this surface layer increased hardness with nitrogen enrichment up to 470HV. The porous surface layer was removed and the tribocorrosion tests were carried out on austenite layer. Changing the parameters in PNSHT should allow obtaining only High Nitrogen Austenitic or Martensitic Layers without porous. Reis [5] performed PNSHT on ISO 5832-1 with different PN temperature and salt bath SHT without formation of porous region. The width of wear track is shown in Fig. 3. Within used test conditions, the tribocorrosion tests revealed better results in PN (F52) and on PNSHT (F521), that was leading at lower temperature.

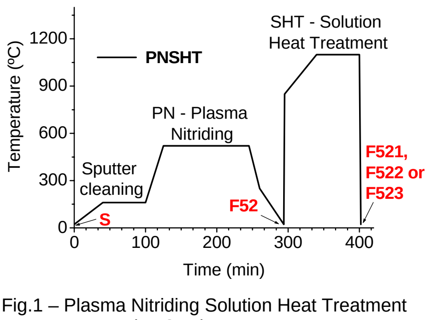

Fig.1 – Plasma Nitriding Solution Heat Treatment (PNSHT) process

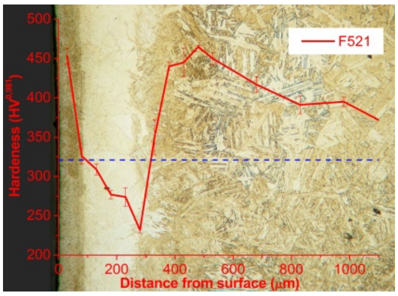

Fig. 2 Microstructure and hardness profile, SHT at 1100ºC

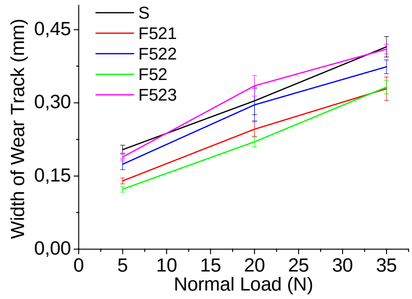

Fig. 3 Width of wear track *vs* normal load.

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