COMPARISON OF WEAR AND CORROSION BEHAVIOR OF THREE DIFFERENT NITRIDING METHODS ON ASI 316L STAINLESS STEEL

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Austenitic stainless steels have been modified for many years with different plasma assisted methods to increase their surface hardness: components and instruments in the food and beverage, as well as chemical, oil and medical industries are using this kind of steel for its excellent corrosion resistance in aggressive environments, while its application is often limited due to poor tribological properties.

In this work, AISI316L stainless steel was nitrided using three different processes: Low Energy Ion Implantation (LEII), Plasma Immersion Ion Implantation (PI3) and DC Pulsed Plasma Nitriding (DCPPN). The process temperature was chosen between 390 and 430 °C in all processes with the aim of preserving their corrosion resistance.

The nitrided samples were analysed by SIMS, XRD and SEM/EDS. Nano- and microhardness were assessed as well as surface roughness. Wear resistance was analysed in a linear reciprocal sliding test against a WC ball with 5 N load. Corrosion behaviour was extensively analysed in saline environments: salt spray fog test and cyclic potentiodynamic polarization in NaCl solution. The $CuSO_4$ spot test was used to detect free iron at the surface and grain boundary sensitization was tested in oxalic acid following ASTM A-262.

Process variables were adjusted in each process in order to achieve a 3 – 5 µm thick nitrided layer with adequate corrosion behaviour. For LEII process, the best conditions were 430°C and 30% pulse duty cycle for nitrogen ion beam. For PI3, temperature should be set lower, 380°C, and for DC plasma nitriding, with 390°C and 20% N_2 partial pressure, these conditions could be achieved. While using the identical substrate material to avoid different influences of the microstructure on diffusion, these processes, governed by dissimilarities in nitrogen uptake and ion bombardment, still use separate temperature measurements, complicating direct comparisons. Nevertheless, corrosion results indicate a preference for either DCPPN or LEII with low ion bombardment. Specific applications for nitrided AISI 316L are discussed regarding advantages and limitations of each process.