Effect of long-term exposure to chloride-containing solution on degradation of plasma-nitrided layer on AISI 316L stainless steel

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Conventional plasma nitriding (PN) at temperatures above 500 °C (so called high-temperature plasma nitriding) is a common thermo-chemical treatment used to increase surface hardness and improve tribological properties of stainless steels. Due to the protective passive surface film stainless steels are generally highly corrosion resistant in oxidation environments, but in chloride-containing ones they are susceptible to the local pitting corrosion. Although these materials own a favorable combination corrosion resistance/adequate mechanical properties, without a special surface treatment they are not suitable as a construction materials for applications where high wear resistance is required.

At a PN temperature of approx. 500 - 550 °C, an intensive diffusion of nitrogen atoms into the surface layer and their reactions with chromium are thermodynamically favored and hard chromium nitrides are formed. On the one hand, the chromium nitrides precipitation brings a significant increase in hardness and wear resistance, on the other hand, due to chromium depletion, corrosion resistance is generally reduced. A worse quality of passive film or loss of passive behavior were recorded by numerous authors mostly by electrochemical measurements performed in various chloride solutions. Studies evaluating the resistance of conventionally plasma-nitrided stainless steels surface to degradation induced by long-term exposure to chloride-containing environments are lacking.

The main objective of this study is an assessment of the plasma-nitrided surface layer degradation during 2-month exposure of plasma-nitrided (530 °C, 24 hours) AISI 316L specimens to 0.5 M NaCl solution at room temperature (20 $\pm$ 3 °C). Evaluation is based on corrosion rates calculated from the mass losses of the specimens during exposure and on the characterization of the plasma-nitrided layer before and after exposure (SEM, roughness, micro-hardness and potentiodynamic polarization performed in 0.5 NaCl solution at room temperature).

The experiment results point to an intensive corrosion degradation of the PN layer during exposure, proved by its lower thickness, decreased micro-hardness and by the changed surface roughness parameters. According to the potentiodynamic polarization parameters measured after exposure, degradation of the plasma-nitrided layer led to an improvement of corrosion behavior compared to the state before.

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