Effect of glow discharge low temperature nitriding and cathodic hydrogenation on hardness and surface morphology depending on crystallographic orientation in SAF 2101 duplex steel

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Abstract

Duplex Stainless Steels (DSSs) that are formed by an approximately equal content of ferritic and austenitic phases are employed in the petrochemical industry. In the present work we submitted SAF2101 to glow discharge nitriding process at 300 °C during 4h. X-ray diffraction allowed identifying the surface microstructure after the nitriding. Electron backscattering scanning diffractometry (EBSD) was employed to determine the phases and orientations of the grains in the duplex steel. X-ray diffraction patterns indicated that nitriding at 300°C promotes only N in solid solution, generating expanded austenite and ferrite. Before and after nitriding the sample surfaces were observed by confocal laser and scanning electron microscopy. Before the nitriding the surface have homogeneous aspect but is possible to differentiate the duplex phase aspect of the steel. After nitriding the surface aspect is different for regions that previously were austenite and ferrite. The N incorporation alters the surface morphology in a different degree in each phase. Twin boundaries, shear bands and roughness are grain dependent. Mechanical properties were investigated by instrumented indentation at nanoscale, following the Oliver and Pharr method. The hardness at shallow depths is about 15 GPa and decreases to the bulk value (3-3.5 GPa). Hardness of both modified structures (FCC and BCC) shows differences at shallow penetrations only before nitriding but not after. The cathodic hydrogenation was performed in sulfuric acid solution at currents of 1000A/m2. Before nitriding the damage of a ferritic grain are more pronounced than for an austenitic. However in austenite it is observed an intensive cracking process. The nitriding at 300° C promotes a decrease in the damage induced by hydrogen embrittlement in both structures.

Keywords: duplex steel, glow discharge, nitriding, hydrogenation, mechanical properties

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