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Nitrogen interstitial solution in austenitic stainless steel by plasma surface modification: enhanced wear and corrosion resistance mechanism

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A high nitrogen face-centered-cubic phase (γ_N) on Fe-Cr-Ni austenitic stainless steel has been formed by a series of plasma/ion nitrogen-modified processes at a low process temperature of 350-450º C. The γ_N phase layer on the austenitic stainless steel has a 10-20 μm thickness with a peak nitrogen content of about 20-35 at.%. The nitrogen interstitials in the austenitic stainless steel resulted in the high microhardness up to 20-22 GPa. The wear and corrosion behaviors of the γ_N phase layer on the austenitic stainless steel were investigated by tribological test on a ball-on-disc tribometer and by electrochemical test using a standard three electrodes system in NaCl solution, respectively. The superior wear and corrosion resistance of the γ_N phase layer was obtained on the austenitic stainless steel. The oxidative wear mechanism of the γ_N phase on the austenitic stainless steel was found through the enhanced nitrogen dissolution instead of an adhesive wear mechanism of the original austenitic stainless steel. With the higher applied load, a transition of the wear mechanisms from oxidative to abrasive wear was carried out, due to a hexagonal-close-packed martensite phase transformation of the γ_N phase during the wear tests. The nitrogen interstitials in the γ_N phase layer contributed to inhibiting the adsorption of aggressive chloride ions in the outer *n*-type iron hydroxide/oxides region, to restricting the migration of space charges as a complete barrier from the *n*-type and *p*-type semiconductors regions, and to neutralizing of the protons due to the formation of ammonia in NaCl solution on the pitting corrosion resistance. The wear and corrosion resistance mechanism of the γ_N phase has been explored based on the composition, microstructure, and wear and corrosion properties of the plasma/ion nitrogen-modified austenitic stainless steel.

Keywords
Austenitic stainless steel
Plasma/ion nitrogen-modified process
Nitrogen interstitial
Wear mechanism
Corrosion mechanism