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Study on the origin of roughness increase on low-temperature plasma nitrided AISI420 martensitic stainless steel

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Low-temperature nitring of martensitic stainless steels is generally applied aiming to enhance the tribological behavior of the steel treated surface. Surface roughness and hardness are among the important parameters influencing the tribological behavior of the treated surface and both can be modified by low-temperature plasma nitriding. Several works deal with the treated surface hardness but the number of works dealing with the nitrited surface roughness is limited. So, the objective of this work was to study the origin of the roughness increase observed after subjecting the AISI420 martensitic stainless steel to low-temperature nitriding. To achieve this purpose AISI420 samples were nitrided using a plasma nitriding apparatus with an auxiliary heating system, enabling independent control of plasma parameters and nitriding temperature. The nitriding treatments were carried out at 300, 350 and 400°C, in a gas mixture composed of 10% Ar + 20% H_2 + 70 N_2 at 3 Torr. Plasma was generated using a 4.2 kHz pulsed DC power supply, with peak voltage of 700V. For each temperature, treatments were carried out using pulse width of 10 and 20 µs, with auxiliary heating system. Treatments were also conducted using only plasma as heating source (auxiliary heating system turned off) with pulse width of 24, 27 and 31 µs for 300, 350 and 400°C, respectively. After treatment samples were characterized by microstructural analysis, X-ray diffractometry, and microhardness measurements. The surface roughness was measured using a laser confocal microscope. Results indicate that temperature and pulse width have influence in several characteristics of the treated layer, including hardness, thickness and phase composition. Considering the roughness, it increases with both the pulse width and the treatment temperature, and results indicate that, at least for the studied treatment conditions, the surface roughness increase is mainly due to structural modifications of the treated layer, being the sputtering only a secondary cause of roughness increase.

Keywords
Low-temperature plasma nitriding
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Roughness