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Laser texturing combined with plasma nitriding as a tool to control the tribological performance of steel components

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Austenitic stainless steels are used as corrosion resistant metallic materials but it is also known about its poor tribological properties. Among other methods, DC pulsed plasma nitriding can increase AISI 316L hardness without affecting anti corrosion properties, but coefficient of friction of nitrided surfaces still remains high. Surface texturing has been used as surface functionalization tool with good results improving friction properties of this steel. Among other techniques used to texture surfaces, Laser patterning has shown to be the most promising process to develop. The main features of these techniques are the low environmental impact as well as an excellent control of the resulting structure. Thus, such methods have been receiving an increasing attention from the tribology community, especially in the macro mechanical applications.

In this work the sequential combination of both plasma nitriding and laser patterning is analyzed comparing to individual treatments over the same material. DC pulsed plasma was performed in a commercial equipment with the usual parameters to obtain expanded austenite without nitride precipitation. For the structuring of the obtained coatings, Direct Laser Interference Patterning (DLIP) was selected due to the outstanding characteristics of this method, including high precision as well as high throughput. The surface topography, friction and wear properties were analyzed using white light interferometry (WLI) and confocal microscopy (CM), scanning electron microscopy (SEM) as well as different tribometers. In addition, the microstructure of the treated and untreated substrates was analyzed using X-ray diffraction (XRD). Corrosion properties were checked using immersion simple tests and salt spray fog test following ASTM B117 standard.

Hardness was increased in plasma nitrided samples up to 850 HV0.05 and the subsequent DLIP did not change the macroscopic properties. XRD diffraction showed the same crystal structure before and after laser texturing. Corrosion properties were sustained after nitriding and after DLIP and the combination of both treatments. Regarding sliding wear tests, plasma nitrided specimens plus DLIP increased AISI 316L wear resistance up to 5 times compared to the blank material, and the Coefficient of Friction (CoF) could be diminished from compared to only nitrided specimens.