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Corrosion behavior of plasma nitrocarburized and post-oxidized AISI 4140 steel in fuel-grade bioethanol

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Plasma nitriding/nitrocarburizing followed by plasma post-oxidizing are standard processes which are been applied for surface treatments of automobile engine parts such as admission valves, piston rings, and gears. Although, surface mechanical and chemical properties of such mechanical components are guaranteed in regular petroleum-based fuels, the new generation of biofuels can generate new detrimental effects on surfaces. In particular, fuel-grade bioethanol can contain corrosion agents such as water, acetic acid, and chloride ions. However and taking into account the greater importance of biofuels in the world energetic matrix, few investigations were devoted in terms of corrosion and pitting behavior of low alloy steels treated by plasma surface modification techniques.
In this work, AISI 4140 low alloy steels were nitrocarburized and post-oxidized by DC pulsed plasma at variable oxidation processing time. Afterward, the modified surfaces were characterized by glancing angle X-ray diffraction, scanning electron microscopy, and nano-indentation measurements. In order to study the corrosion and pitting behavior of the plasma modified surfaces, the samples were maintained in contact with fuel-grade bioethanol according to the Brazilian standard NBR 8265/1983. During some months, the change in weight, the open circuit potential and the surface morphology by optical and scanning electron microscopies were recorded.
The outermost oxide layer is constituted only by magnetite. The corrosion and pitting behavior depends on surface morphology and oxide microstructure. Although the oxide layer thickness increases with oxidation processing time, the corrosion resistance shows a maximum at intermediate processing times. Finally, the relationship between the corrosion resistance and the presence of MnS inclusions is discussed.

Keywords
plasma-assisted-diffusion
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