

Exploring sol-gel sealing capabilities for PEO-coated AA2024-T3 and AA2198-T851 aluminum alloys: Electrochemical and Wear investigations

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Widely employed in the aerospace sector, the 2xxx aluminum alloys are recognized for their high strength. Their main alloying compound is copper inducing the formation of intermetallics which increase their mechanical properties and their susceptibility to localized corrosion. In AA2024-T3 alloy, two primary types of particles emerge including the S-phase, consisting of Al₂CuMg, and particles containing Fe, Cu, Al, and Mn expressed as Al₆(Cu, Mn, Fe). The AA2198-T851 alloy stands as a representative of third-generation aluminum alloys, characterized by its composition comprising elements such as Al, Cu, and Li, alongside traces of Mg, Ag, and Zn. To overcome the localized corrosion in such alloys, some strategies have been reported in which surface treatment plays a crucial role. In contrast to anodizing, the plasma electrolytic oxidation (PEO) technique involves higher voltage, leading to species diffusion, plasma reactions, and electrochemical reactions. Considering the intrinsic porosity in layers generated via the plasma electrolytic oxidation process, sol-gel coatings have gained a lot of attention for their environmentally friendly and robust protective qualities when applied as a post-treatment ^{1,2}. In this study, a hybrid sol-gel layer (30% V/V) obtained from tetraethoxysilane (TEOS) and 3-glycidoxypropyltrimethoxysilane (GPTMS) sol-gel solution was applied on both alloys previously covered by an optimized PEO layer using a solution containing sodium silicate and potassium hydroxide solution as electrolyte. The sealing capabilities of the sol-gel layer were scrutinized for the PEO coating applied on AA2024-T3 and AA2198-T851 aluminum alloys. Electrochemical Impedance Spectroscopy (EIS) and Field Emission Scanning Electron Microscopy (FE-SEM) confirmed that for the same operating conditions, the morphological properties of the PEO coating depend on the substrate nature and play a key role in the corrosion protection given by such duplex coatings.

References

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