Smart hybrid coating reinforced with modified clay nano reservoirs for the plasma electrolytic oxidation (PEO) layer on AA2024

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Abstract

Aluminum alloys in the Al-Cu-Mg system attract attention due to their favorable weight to strength ratio as a structural material for aerospace industries and their good mechanical properties due to the copper addition. The most common drawback of AA2024 is its vulnerability to the local corrosion phenomenon which is why a surface treatment is required to lengthen the lifetime and to enhance its corrosion protective properties. Regarding, PEO as an eco-friendly and versatile procedure plays a significant role among the various methods of surface treatment for lightweight alloys. It can be compared to an anodizing process obtained at high voltage and associated with thermal diffusion of species, plasma reactions, and electrochemical reactions taking place at the electrodes. Due to the intrinsic porosity of the layers formed by the PEO process, the application of silane-based coatings as an eco-friendly layer is a promising way to diminish penetration of the corrosive species into the PEO coating by pores sealing. In this study, a hybrid sol-gel solution based on tetraethoxysilane (TEOS) and 3-glycidoxypropyltrimethoxysilane (GPTMS) with 30% V/V concentration was incorporated with sodium montmorillonite (Na-MMT) along with adsorbed corrosion inhibitors to achieve dual-functional sol-gel coating with active/barrier anti-corrosion performance. Electrochemical impedance spectroscopy (EIS) results reported the huge impact of

the sealing ability of the sol-gel system for the PEO layer in 0.1M NaCl solution especially for the sol-gel coatings modified with clay/inhibitors nanoparticles. The morphology and the duplex coating structure were highlighted by using a scanning electron microscope (SEM). To this end, scanning vibrating electrode technique (SVET) outcomes reflected the self-healing ability of the coatings modified with clay/inhibitor nanoparticles. The presence of lamellar structure of clay nanoparticles not only increased the barrier performance but also being as reservoirs provided the controllable leaching of the active specimens to attain a long-lasting protective system.

Keywords: *Plasma electrolytic oxidation (PEO); Sol-gel; AA2024; SVET; Clay.*