Improving corrosion resistance in plasma electrolytic oxidation (PEO) coatings through the integration of a modified sol-gel layer incorporating hexagonal boron nitride (h-BN) nanosheets

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Abstract

Sol-gel sealing is recognized as a straightforward and efficient method to enhance the protective performance of PEO coatings. While sol-gel coatings are reliable and corrosion-resistant, the addition of nanoparticles has shown improved barrier properties. Our objective was to validate the positive impact of nanosheet incorporation and the influence of h-BN functionalization in the sol-gel/PEO coating system on AA2024. The PEO layer on AA2024 was acquired at 5 A constant Anodic current, 100 Hz frequency, and 30% duty cycle in an electrolyte containing sodium silicate and potassium hydroxide. Specifically, we utilized as-received, oxidized, and functionalized nanopowders at different concentrations. (3-Aminopropyl)triethoxysilane (APTES) is a suitable candidate for the h-BN functionalizing as the sol-gel layer is the combination of tetraethyl orthosilicate (TEOS) and (3-Glycidyloxypropyl)trimethoxysilane (GPTMS). Some chemical techniques such as Fourier-transform infrared spectroscopy (FTIR) and Zeta potential measurement confirmed the successful oxidation and functionalization process. Rheology measurement affirmed the influence of the h-BN functionalization on its compactness and the network viscosity. The presence of nanosheets was visualized by Field Emission Scanning Electron Microscopy (FESEM) in the sol-gel coating over the PEO layer. The electrochemical impedance spectroscopy (EIS) analysis reported the greatest corrosion resistance found in the modified sol-gel coating with the functionalized h-BN after three weeks of immersion in 0.1 M NaCl solution.