

Dual-Functional Ag-MOF Nanoparticle Composite Coatings for Enhanced Anticorrosion and Antibacterial Performance on Aluminum Alloys

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Abstract The development of bifunctional composite coatings with both corrosion resistance and antibacterial activity is crucial for protecting aluminum alloys from corrosion and microbial contamination, particularly in aerospace and transportation sectors. In this study, Ag-MOF powders were successfully synthesized via a simple and mild liquid-phase method, using AgNO₃, trimesic acid (H₃BTC), and imidazole as precursors. The Ag-MOF demonstrated significant antibacterial activity, primarily due to the controlled release of Ag⁺ and its excellent dispersion within the coating matrix. Furthermore, a bifunctional composite coating was developed by introducing a cerium-doped sol-gel primer, which enhanced both antibacterial and corrosion resistance properties. Electrochemical tests revealed that the composite coating achieved the highest impedance modulus and the lowest corrosion current density in the low-frequency region, attributed to the synergistic effect of the corrosion inhibitor and the barrier properties of the film. After 7 d of immersion, the impedance modulus remained around 10⁶ Ω·cm², signifying superior long-term corrosion resistance compared to pure acrylic coatings. This study provides a novel approach for the application of advanced antibacterial and anticorrosion materials in coatings and underscores the potential of composite coatings in harsh corrosive environments.

Keywords Metal organic frameworks; Antibacterial properties; Corrosion resistance; Composite coating; AA2024 aluminum alloy