Plasma-Activated Aluminium for High-Performance Epoxy/Graphene Oxide Coatings

Reetik Singh
Department of Physics, Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India

Sanat Kumar Mukherjee *
Department of Physics, Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India

Abstract

This study demonstrates that atmospheric pressure plasma treatment (APPT) offers an eco-friendly way to activate AA7075 Al aluminium surfaces, significantly improving coating adhesion and surface wettability by increasing surface free energy, including both dispersive (γ_L^D) and specific polar (γ_L^{SP}) components and lowering the water contact angle. These surface modifications contribute to enhanced coating adhesion and greater corrosion resistance. Plasma treatment introduced polar groups, increasing surface free energy from 43.5 ± 2.1 to 78.63 ± 1.6 $mJ.m^{-2}$. In parallel, graphene oxide (GO) sheets were synthesized via a simple two-step method and incorporated into an epoxy matrix to form a GO-reinforced epoxy composite coating. This composite was applied onto the plasma-activated aluminium surface to study the synergistic effects of surface activation and composite coating. Adhesion tape tests demonstrated excellent adhesion performance, confirming the efficacy of plasma treatment in improving coating adherence. Potentiodynamic polarization results revealed a significant increase in corrosion resistance, with (Ecorr) shifting from -0.9 to -0.4 V for EP/GO coating system on plasma treated. Furthermore, electrochemical impedance spectroscopy (EIS) data confirmed that the EP/GO coating on plasma-treated AA7075 exhibited superior corrosion resistance relative to untreated samples, reinforcing the protective benefits of this treatment.

Keywords

Oxygen plasma-treatment, wettability, composite coating, adhesion, EIS.