Anticorrosion investigation of natural tetrahydropalmitine for 2024 Al alloy/acid-chloride system

Wilfred Emori[1], Peter C. Okafor[2]

[1]*School of Materials Science and Engineering, Sichuan University of Science and Engineering, Zigong 643000, Sichuan, PR China*

[2]*Corrosion and Electrochemistry Research Group, Department of Pure and Applied Chemistry, University of Calabar, P.M.B. 1115, Calabar, Nigeria*

Presenter's e-mail address: wemori@suse.edu.cn

Abstract 2024 aluminum alloy, a member of the Al-Cu-Mg alloy family, has piqued research interest due to its extensive application in aerospace, ocean environment, oil and gas, and other industries, but its high Cu content, the major alloying element, is a major drawback to its use, especially in applications requiring high corrosion resistance. This is particularly problematic in chloride systems containing oxygen. Herein, we developed a protection strategy for 2024 Al alloy in an acid-chloride environment using natural tetrahydropalmitine (THP) isolated from *Corydalis yanhusuo*, a traditional Chinese medicine. THP was effectively characterized from its ^{1}H NMR, ^{13}C NMR, and FTIR spectra, and its anticorrosion potentials were methodically investigated by electrochemical, gravimetry and theoretical experiments. Upon the addition of THP to the test system, EIS measurements revealed a steady increase in the Nyquist semicircles, as well as the Bode impedance and phase angle plots, attaining an optimum inhibition efficiency of 91.1% at 2.0 g/L THP. The Tafel plots manifested mixed-type anticorrosion effects with dominant cathodic properties, ascribed to the ordered shielding effect of both the hydrogen evolution reaction and the oxidation of oxide-free ions. Time-dependent corrosion assessment showed that the surface of 2024 Al alloy remained increasingly protected with time up to a maximum of 413 Ωcm^2 after 168 h. This was attributed to a combined effect of the formation of stable oxide films and adsorbed THP on the surface of the metal surface. SEM afforded the proof of THP adsorption on 2024 Al while XPS offered clarity into its anticorrosion mechanism. Conceptual DFT parameters, molecular electrostatic potential and molecular dynamics simulations were performed to understand the inhibition process of THP on Al surface. Generally, THP was proven to be a viable and sustainable bio-based anticorrosion material for the protection of aluminum alloys.

Keywords 2024 aluminum alloy, Acid-chloride system, Corrosion inhibition, Electrochemical investigation, Gravimetry, Computation