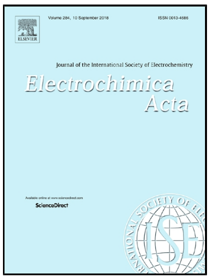

Carboxylic acids as efficient corrosion inhibitors of aluminium alloys in alkaline media

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Carboxylic acids as efficient corrosion inhibitors of aluminium alloys in alkaline media

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Abstract

The efficiency of AA5754 aluminium alloy corrosion inhibition achieved with maleic, malic, succinic, tartaric, citric, tricarballylic acids and serine in alkaline environment (pH 11) was examined. Selected corrosion inhibitors are characterized by different numbers and distribution of carbonyl and hydroxyl groups within their molecules. We have proposed and verified a novel approach for determining the adsorption isotherms based on the impedance measurements in galvanostatic mode (g-DEIS), allowing to distinguish subtle changes in the adsorption dynamics. It was shown that g-DEIS precisely determines the inhibitor concentration required for the full coverage of aluminium surface with the adsorbed inhibitor monolayer. Our approach was then cross-verified with the ellipsometry, cyclic polarization and classic EIS measurements, while the SEM and XPS analyses served to determine changes in the surface topography and chemistry. We have demonstrated that the investigated compounds significantly decelerate the corrosion rate of AA5754 at low inhibitor concentrations. Inhibition efficiency exceeds 99% at 6.9 mM for tricarballylic, 8.1 mM for citric and 12.0 mM for tartaric acid. The inhibition efficiency was primarily dependent on the high number of carbonyl groups in the molecule, while the inhibition provided by monocarboxylic amino acid (serine) was negligible, reaching 60% at 20 mM. The plotted isotherms fitted the Langmuir adsorption model, with similar values of Gibbs free energy for each studied inhibitor. The adsorption of carboxylic acids onto the surface of aluminium occurred via ligand exchange mechanism. On the basis of electrochemical and XPS studies, we claim that the role played by hydroxyl groups is secondary, while their presence slightly worsens the corrosion resistance of aluminium.

Keywords: AA5754 alloy, corrosion inhibitor, dynamic electrochemical impedance spectroscopy, carboxylic acids