

Article

Covalent surface modification of 2024 aluminum alloy surface by self-assembly dodecyl phosphate film towards corrosion protection

Cheng-Cheng Pan ¹, Shi-Zhe Song ¹, Wei-Xian Jin ², Wen-bin Hu ¹, Bao-Min Fan ³
and Da-Hai Xia ^{1,*}

¹ Tianjin Key Laboratory of Composite and Functional Materials, School of Materials Science and Engineering, Tianjin University, Tianjin, 300354, China

² Zhoushan Marine Corrosion Institute of Central Research Institute of Iron and Steel, Zhoushan, 316003, China

³ School of Materials and Mechanical Engineering, Beijing Technology and Business University, Beijing, 100048, China

Abstracts: This work was to prepare a layer of dodecyl phosphate (DDPO4) film on 2024 aluminum alloy substrate for corrosion protection by self-assembling. The prepared DDPO4 self-assembly monolayers (SAMs) properties were characterized by X-ray photoelectron spectroscopy (XPS), water contact angle measurement (CA), and electrochemical impedance spectroscopy (EIS). Experimental results indicated that DDPO4 was successfully assembled on aluminum alloy substrate via covalent bond attachment. The modified surface was hydrophobic due to the DDPO4 attached to the oxide surface and a hydrocarbon tail-up orientation. In order to build a molecular adsorption dynamics model, the impact of temperature and pH values for assembling process has also been evaluated. Accelerated corrosion test showed that the DDPO4 modified 2024 aluminum alloy substrate exhibited excellent corrosion resistance in an electrolyte containing 0.01M Cl⁻ + 0.01M SO₄²⁻, and no apparent corrosion pits were observed after an exposure of 96 h. The charge transfer resistance of the DDPO4 covered aluminum alloy was ~100 times larger than that of the blank aluminum alloy.

The results of molecular dynamic (MD) simulation for DDPO4 adsorbed on the Al₂O₃(110) face indicate that the head group of DDPO4 is the active group and bind as tridentate with the O in P=O bond can adsorbed on the Al₂O₃ surface.

Keywords: LY12 aluminum alloy; self-assembly monolayers; molecular dynamic simulation

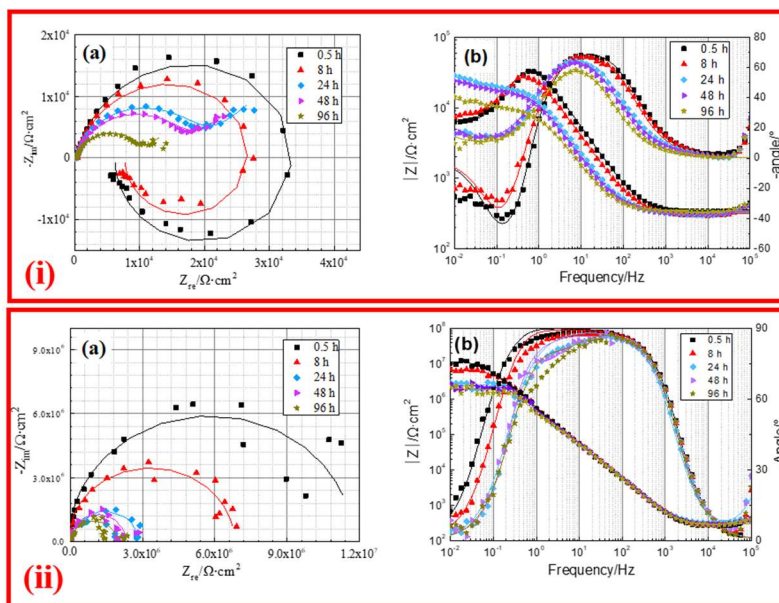


Figure 1. Electrochemical impedance spectroscopy of the blank (i) and SAMs modified (ii) LY12 aluminum alloy in the aqueous solution of 0.01M Cl^- + 0.01M SO_4^{2-} .