11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Silane film with cerium obtained by sol-gel process for post-treatment on AA2024-T3 alloy: effect of corrosion inhibitor concentrations

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Abstract – Many processes have been studied to improve the corrosion resistance of aluminum alloys. The post-treatment with silane films have been suggested as alternative to chromate process, and the addition of corrosion inhibitors to silane films has been recommended to improve the anticorrosion performance of this films. Results obtained in this work showed that there is a critical concentration of cerium for optimizing the corrosion resistance of the silane film. Above this concentration the inhibitor impair the barrier effect promoted by silane film.

Aluminum and aluminum alloys have been extensively used in many technological applications, however, pitting corrosion process takes place in the presence of aggressive ions like chlorides. In order to prevent the corrosion process, surface treatments based on environmentally compliant coatings have been developed. Silane films have been suggested as alternative to post-treatment of aluminum alloys [1-3]. This film acts as a physical barrier that difficult the infiltration of aggressive species in the direction of metallic substrate. The addition of corrosion inhibitors to silane films has been suggested with aim the improving the anticorrosion performance of this films. Among the rare earth salts, the cerium composts are the most used as inhibitors. When introduced in the silane matrix, the cerium improves the corrosion resistance and gives the self-healing properties.

The aim of the present work was to study the corrosion resistance of aluminum alloy AA2024-T3 substrates post-treated with sol-gel doped with cerium (zero, 0.01 M e 0.05 M). The samples surface were analyses by atomic scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS) and Rutherford backscattering spectroscopy (RBS). And the electrochemical behavior was evaluated by open circuit potential (OCP) and polarization measurements, electrochemical impedance spectroscopy (EIS) and salt spray test (ASTM B-117-03). The results showed that the silane film forms a uniform barrier on the aluminum alloy. Moreover,the open circuit potential values (OCP) were influenced by the presence of silane film. The samples treated with silane film presented values of potentials less actives compared to the aluminum alloy (Figure 1). However the increase of concentration of cerium on silane films promoted the displacement of the open circuit potential in direction to more active potential values. This behavior indicates impair of the barrier effect promoted by silane film due to increase of cerium concentration incorporated that destabilized the silane matrix, decreasing the corrosion resistance of the coating. The EIS tests (Figure 2) confirmed results obtained by OCP and polarization measurements. It was possible to observe that there is a critical concentration of cerium necessary for optimizing the corrosion resistance of the silane film studied. Above this concentration the inhibitor impair the barrier effect promoted by the silane film.

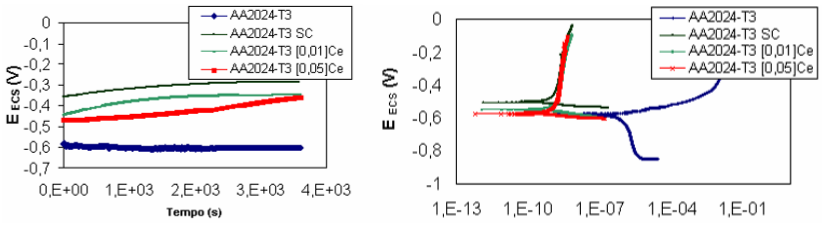

Figure 1: a) Open circuit potential in 0,5M NaCl solution **b)** polarization curves by a scanning rate of 5 mV/s.

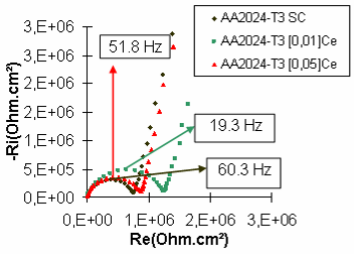

Figure 2: EIS measurements obtained for samples immersed for 1 hour in 0,5M NaCl solution.

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