ELECTRODEPOSITION OF ADHERENT PANI-FILMS ON ALUMINUM ALLOY 2024-T3 AND ITS CORROSION PROTECTION

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Introduction

Aluminum alloy 2024-T3 containing 4-5 % Cu is been extensively used in the aircraft industry. Corrosion of this alloy can be accelerated due to a galvanic pair between aluminum and copper. It is important to protect the alloy by means of noble coatings. PAni is going to play an important role as corrosion inhibitor, since the usual protection by chromate is harmful. Cr(VI) is carcinogenic and extremely mobile, being weakly bound to inorganic surfaces. Protection of aluminum alloy 7075-T6 by PAni containing a polyanion has been studied in 0.5 M NaCl [1]. By comparing the corrosion protection with that of chromate, the authors concluded that doped PAni is more effective than chromate; and also more protective than the undoped form.

Epstein et al. [2] reported that sulfonated PAni and emeraldine base are effective in inhibiting corrosion of AA2024-T3 in 0.1 M NaCl.. They also suggested that those coatings dissolve the copper containing corrosion products, and thus, the galvanic pair between copper and aluminum can be eliminated and the corrosion rate reduced.

Experimental

Alloy samples were cut as in the literature [3]. They were embedded in acrylic resin showing a free surface area of 0.45 cm^2. The surface was polished in emery paper from 320 to 1200 grit, degreased in ethanol and dried at 40°C. The surface was previously treated in 1.3 % aqueous solution of alizarin for 40 minutes, washed and dried at 40 ^{o}C. PAni films were deposited galvanostatically at 1 mA cm^{-2} and potentiostatically at +0.750 V vs. saturated calomel electrode (SCE). The deposition electrolyte was 0.12 M Aniline in 0.5 M $H_2C_2O_4$ pH 0.6. Extremely adherent films have been obtained, confirmed by the Sellotape-test. The freshly obtained films were submitted to doping (at +1.0 V) and undoping (at -0.2 V) processes in monomer-free solution for 5 minutes, and succesively their electrochemical responses were measured. Corrosion studies were performed by measuring the potentiodynamic polarization curves in 0.1 M NaCl at 1 mV s^{-1}.

Results

The best adherent films are those obtained after 5 succesive galvanostatic depositions at 1 mA cm^{-2} for 500 seconds. Films deposited by 2 succesive potentiostatic depositions at +0.750 V for 1200 seconds presented similar adherence. It should be noted that the galvanostatic deposition is more efficient than the potentiostatic deposition. The induction deposition period was around 50 seconds for both methods. The doping level of the galvanostatic film attains much lower value than that of potentiostatic film, indicating more passivation but resulting in a loss of electroactivity. The responses in Figure 1 of both galvanostatic and potentiostatic films after doping confirm this statement (the doped potentiostaic film shows electroactivity). The dedoped films rather maintain their electroactivity.

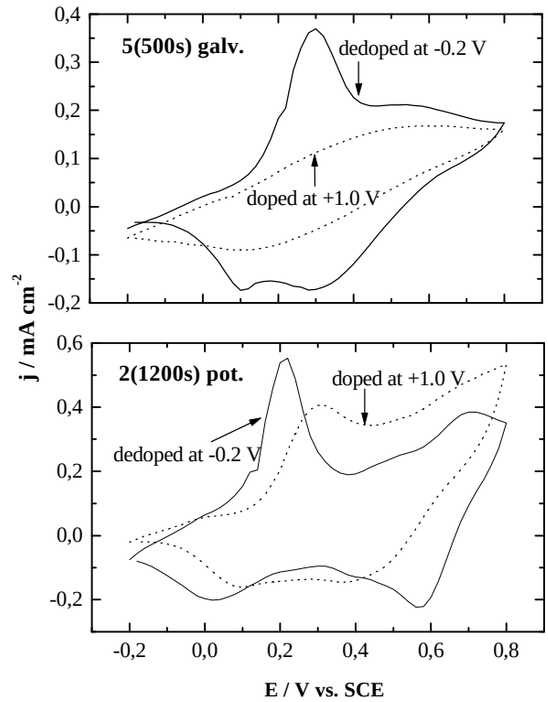

Figure 1. Electrochemical responses of PAnis on AA-2024 in depoed and undoped condition.

The polarization curves shows that galvanostatic and potentiostatic deposited PAni are effective in protecting aluminum alloy 2024-T3 in 0.1 M NaCl. This is giving by the protection potentials shifts to noble values compared to the bare alloy. The galvanostatic film is even more protective than a bi-layered film, a CV-formed film onto a 2 (500seconds) galvanostatic formed film.

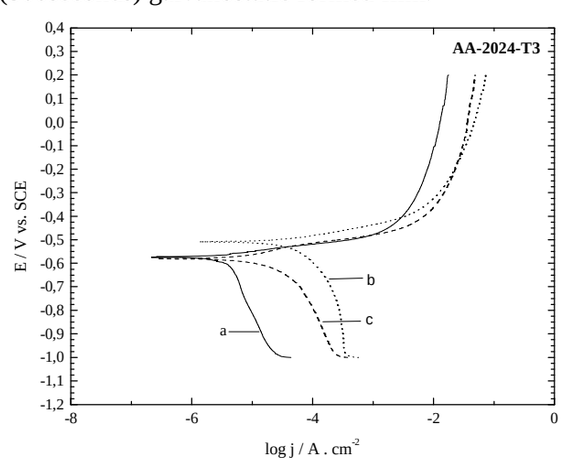

Figure 2. Potentiodynamic polarization curves in 0.1 M NaCl for (a) bare alloy, (b) galvanostatic deposited film from 0.5 M $H_2C_2O_4$ and (c) CV-film from 1 M phosphate buffer solution on a 2(500 s) galvanostatic film.

1. R. Racicot, R. Brown, S.C. Yang, *Synth. Met.*, **85**, 1263 (1997)
2. A.J. Epstein, J.A.O. Smalfield, H. Guan, M. Fahlman, *Synth. Met.*, **102**, 1374(2000)
3. D.W. DeBerry, *J. Electrochem. Soc.*, **132**, 1022 (1985)