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ORIGINAL PAPER

Polyaniline and polypyrrole/TiO_2 nanocomposite coatings on Al1050: electrosynthesis, characterization and their corrosion protection ability in saltwater media

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Abstract Polyaniline (PANI), polypyrrole (PPy) nanofilms, PANI/TiO_2 and PPy/TiO_2 nanocomposites were synthesized electrochemically on Al1050 electrode. The formation of PANI and PPy nanofilms and PANI/TiO_2 and PPy/TiO_2 nanocomposites was characterized by Fourier transform infrared spectroscopy-attenuated total reflectance (FTIR-ATR), UV–visible absorption spectroscopy (UV–Vis), scanning electron microscopy (SEM), energy dispersion X-ray analysis (EDX), and electrochemical impedance spectroscopy (EIS). The comparative morphologic, spectroscopic and electrochemical properties of the prepared PANI and PPy nanofilms and nanocomposites were investigated in this study. The effectiveness of polymer and nanocomposite films in preventing the corrosion of Al1050 was tested in 3.5 % NaCl solution. For corrosion tests, anodic polarization curves and EIS were used to investigate their corrosion protection capability in saltwater solution. The highest, low frequency capacitance values were obtained as $C_{LF} = 60.76$ and 12.8 mF cm^{-2} for PANI/TiO_2 and PPy/TiO_2 nanocomposites, respectively. The results of these studies revealed that the corrosion protection efficiency (PE) of the PANI/TiO_2 (PE = 97.2 %), PPy/TiO_2 (PE = 97.4 %) nanocomposites coated on Al1050 electrode was higher than that of PANI (PE = 96.4 %), PPy (PE = 94.9 %) and uncoated Al1050 electrodes. These nanocomposites can be used in airplanes, space technology, automobiles, electronics, and building sectors, as well.

Keywords Electrochemical polarization · Polyaniline · Polypyrrole · Corrosion protection efficiency · EIS · Al1050 electrode · TiO_2 · Nanocomposite

Introduction

Conducting polymers have been candidates for corrosion protection, mechanical strength, stability and the possibility of both oxidative and electrochemical synthesis, etc. [1, 2]. New nanocomposites have been investigated extensively in recent years due to their wide range of potential use in industrial applications. The synthesis of novel, conducting polymers and nanocomposites for their physical properties has been of particular interest.

Polyaniline (PANI) is a versatile material for potential applications as electrodes in primary and secondary batteries [3], microelectronics [4], sensors, and actuators, etc. [5]. PANI and nanocomposites of PANI have been reported for their synthesis with Fe_3O_4 [6], ZrO_2 [7], montmorillonite [8], and gold nanoparticles [9]. PANI/TiO_2 nanocomposites have been studied by Bahramian [10] and Karim et al. [11].

Le et al. [12] studied PANI on 316 L stainless steel, using varying cycle numbers by cyclic voltammetry in 0.1 M H_2SO_4 solution containing fluoride. Hermas et al. [13] studied the deposition of PANI on 304 stainless steel by electrochemical techniques as a protective coating in 1 M H_2SO_4 medium at 45 °C. In this study, PANI improved the passivity of the steel, which remained passive in an aggressive medium for several weeks. PANI passivated surfaces have been electrodeposited by many researchers [14].

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