



Electropolymerization, characterization and corrosion performance of poly(*N*-ethylaniline) on copper

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ABSTRACT

Poly(*N*-ethylaniline) (PNEA) coatings were grown by cyclic voltammetry technique on copper from 0.1 M *N*-ethylaniline (NEA) in 0.3 M oxalic acid solution. The optimum conditions (e.g. upper potential limit, scan rate and cycle number) effect on corrosion performance of synthesized PNEA films were determined in order to obtain best protection results against corrosion. The electrodeposited coatings were characterized by cyclic voltammetry (CV), Fourier Transform Infrared-Attenuated Total Reflectance (FTIR-ATR) spectroscopy and scanning electron microscopy (SEM). Redox parameters were found after electrochemical tests and results of stability tests of these films impart an electroactive behavior that is composed of both diffusion control and thin film behavior. In addition, corrosion performance of PNEA coatings were investigated in 0.1 M H₂SO₄ by Tafel extrapolation and electrochemical impedance spectroscopy (EIS) techniques.

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1. Introduction

Electroactive polymers have attracted a great deal of attention during the past decade due to their unusual electrical/electronic properties. These materials have a great potential for commercial applications [1,2] and a variety of such materials have been explored. Recently, conducting polymers have received considerable interest as corrosion protective coatings for oxidizable metals. Conducting polymers are synthesized either chemically or electrochemically. Chemically synthesized polymers are deposited from dispersion [3], spin coating [4] and electrostatic spraying technique [5]. It is now well established that the electrochemical polymerization is a simple and most convenient method for the synthesizing novel conducting polymers on metallic surfaces [6,7]. Because of its low resistivity and its improved electro-migration performance [8], copper is a widely used reactive metal in electrical and electronic devices. It is rapidly replacing aluminum as the interconnect material of choice in integrated circuits, particularly microprocessors. Despite the fact that copper is noble, it readily corrodes in a variety of environments [9]. However, only very few studies have been carried out on the protection of copper by conducting polymer coatings in spite of its wide range of technological application [10–12].

Since dissolution of oxidizable metals, like copper, occurs at lower potential than that of monomer oxidation potential, metal must be passivated to generate a suitable surface prior to the electropolymerization of electroactive specimens. Several works are reported in literature relating to the deposition of polypyrrole on Cu using supporting electrolytes such as sodium oxalate [13] and oxalic acid [14,15]. Özyılmaz et al. reported the use of sodium oxalate as supporting electrolyte for the deposition of polyaniline on copper [16]. The presence of substituted polyaniline (PANI) may result in material which is more soluble and readily processable while retaining the appealing characteristic of PANI. In this respect, substituted derivatives of polyaniline could also serve as a good alternative for polyaniline. Corrosion performances of ring substituted anilines have been studied extensively [17–26]. However few reports exist on the corrosion performance of *N*-substituted polyanilines such as poly(*N*-ethylaniline) (PNEA). Yağan et al. reported electrodeposition of PNEA from aqueous oxalic acid solution on Fe, mild steel and stainless steel. They also studied the protective effect of PNEA coatings in various environments [27–30]. The main objective of the present study is to electropolymerize *N*-ethylaniline on copper electrode from aqueous oxalic acid solution via cyclic voltammetry (CV) technique by optimizing the electrodeposition conditions. The reasons for selecting the NEA monomer are many and clear. These reasons can be listed as followings; (a) NEA is a *N*-substituted derivative of aniline with an ethyl group substituted at *N* atom of aniline and NEA is commercially available at low cost and (b) the NEA monomer has quite good solubility in water therefore it is possible to perform electrochemical polymerization in aqueous media

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