Comparison of Polyaniline and Poly(*ortho*-ethoxyaniline) Corrosion Protection Properties

M. Kraljić, Z. Mandić, Lj. Duić

Faculty of Chemical Engineering and Technology, University of Zagreb, Zagreb, Croatia

Polyaniline (PANI) and poly(*ortho*-ethoxyaniline) (POEA) were electrosynthesised on a stainless steel electrode in phosphoric acid solution (3 moldm^{-3}), using cyclic voltammetry. Concentrations of monomers were 0.5 mol dm^{-3}.

It was found that polyaniline synthesised in phosphoric acid has good protecting properties [1, 2], therefore, phosphoric acid was used for the synthesis of POEA. To be able to characterise these polymers the synthesis was carried out on Pt, as well. Since the emeraldine form of polyaniline is the one that protects steel against corrosion, [1] it was necessary to detect the potential window of emeraldine for POEA. It was found that the potential window for emeraldine in the case of POEA is much smaller than in case of PANI.

POEA protected steel electrodes were examined in 3 mol dm^{-3} H_3PO_4 by monitoring the open circuit potential vs. time and it was found that both, PANI and POEA, stabilise the potential of steel within the passive region (Fig. 1) and that these films have similar protecting properties.

Using electrochemical impedance spectroscopy (EIS) it was found that, in the potential range of emeraldine, PANI and POEA on Pt show capacitive behaviour. However, EIS measurements of PANI and POEA on stainless steel showed different behaviour of these two films. On stainless steel, the thicker PANI film exhibited capacitive behaviour with small resistance at high frequencies. The thinner PANI film exhibited much higher resistance which is specific for leucoemeraldine. The resistance is caused by steel oxidation and transformation of emeraldine to leucoemeraldine. An equivalent circuit with the corresponding parameters was developed for each film obtained on stainless steel. Using EIS it was found that PANI provides corrosion protection. Measurements with POEA on steel showed two resistivity components. One is caused by the increased share of leucoemeraldine, and the other by resistance on the metal/conductive polymer interface. The resistance on the metal/conducting polymer interface was smaller than the resistance obtained for bare stainless steel in contact with the supporting electrolyte. It is assumed that a thinner oxide forms when POEA is used. Corrosion of stainless steel protected by POEA is slower and results in a thinner oxide [3]. From these findings it is possible to conclude that POEA protects steel from corrosion.

[1] M. Kraljić, Z. Mandić, Lj. Duić: Anti-Corrosion Properties of Polyaniline Coating, in: P.L. Bonora and F. Deflorian (Ed.): Electrochemical Approach to Selected Corrosion and Corrosion Control Studies, IOM Communications Ltd., London, 2000, 87-99.

[2] M.C. Bernard, A. Hugot-LeGoff, S. Joiret, Synth. Met. 102 (1999) 1383.

[3] M. Fahlman, S. Jasty, A. J. Epstein, Synth. Met. 85 (1997) 1323.

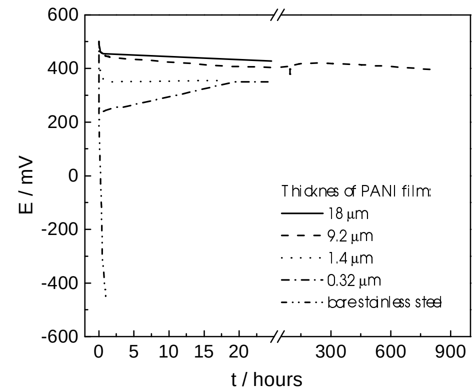

Fig. 1. The open circuit potential vs. time for bare stainless steel and stainless steel protected with PANI

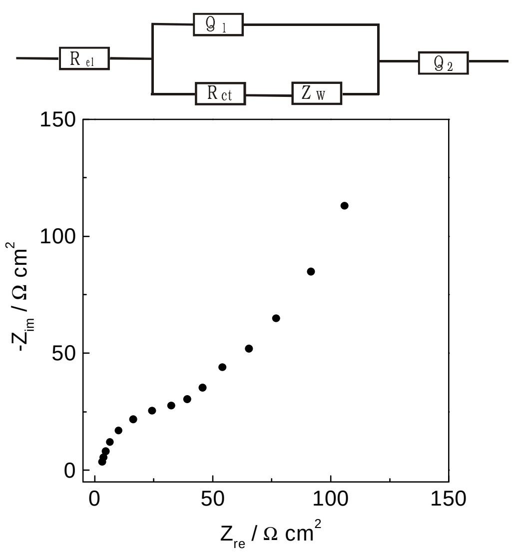

Fig. 2. Nyquist diagram for stainless steel PANI electrode in 3 moldm^{-3} H_3PO_4 and appropriate equivalent circuit.

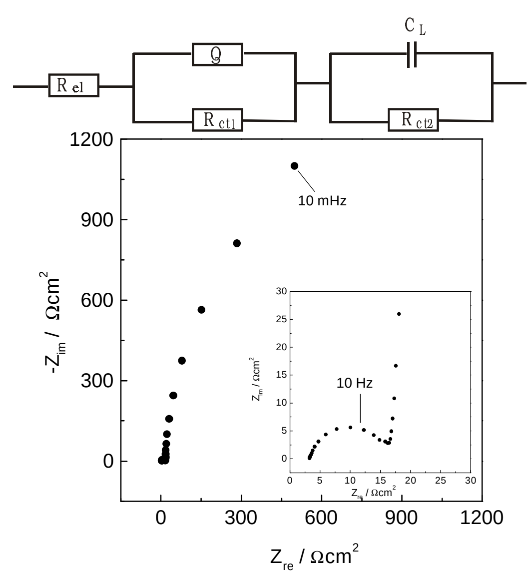

Fig. 3. Nyquist diagram for stainless steel POEA electrode in 3 moldm^{-3} H_3PO_4 and appropriate equivalent circuit.