

The Effect of Polyaniline and Modified Polyaniline Coatings on Stainless Steel Corrosion Protection

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In recent years it has been recognized that conductive polymer coatings on steel surface [1-4] stabilize the potential of the substrate in the passivation region and thus protect it from corrosion.

This work investigates the corrosion protection of stainless steel by electrochemically deposited polyaniline (PANI) and modified polyaniline coatings. PANI coatings on stainless steel (13% Cr) were synthesized from 0.5 M solutions of aniline in 3 M H₂SO₄, and in 3M H₃PO₄, and from 0.5 M aniline with additions of 5, 10 and 25 mM of *ortho*-phenylenediamine (OPDA1, OPDA2, OPDA5) in 3 M H₂SO₄.

The composition of the solution for coatings influences the rate of PANI deposition. It is found that in sulfuric acid solutions the rate of PANI coating growth decreases with the increase of OPDA addition (Fig. 1). The decrease in PANI growth rate can be attributed to the change in polymerization mechanism due to the OPDA additions. The presence of OPDA can influence the appearance of the ladder-like structure, the branching of the polymer chains via amino- groups in *ortho*-position, as well as the earlier termination of the chain growth. The change in the polymerization mechanism leads also to the different morphology what is observed on SEM micrographs.

The efficiency of PANI coatings in stainless steel corrosion protection was tested by observing the open circuit potential (E_{oc}) of the coated sample immersed in pure supporting electrolyte. As shown in Fig. 2 the time of maintaining the potential in the passive region increases with the increase in the thickness of PANI layer (PANI1: Q=18 mC, PANI2: Q=80 mC) and with the increase of OPDA addition.

From earlier work it is known that PANI coatings, synthesized from phosphoric acid solutions, offer corrosion protection superior to PANI coatings from sulfuric acid solutions [4]. In this work, therefore, coatings of different thickness were tested. Since the earlier investigated PANIPO₄ thickness proved to offer long time corrosion protection, the tests were carried out for thinner layers of PANIPO₄ coatings.

For all the tested coatings of the thickness >1 mC cm⁻² ($d \approx 0.02 \mu\text{m}$, $N = 10$ cycles) E_{oc} during the time of observation (150–200 hours) was maintained in the passive potential region (Fig. 3). A comparison of the rate of PANI growth in dependence of the number of cycles (N) during the syntheses is given in Fig. 4.

References:

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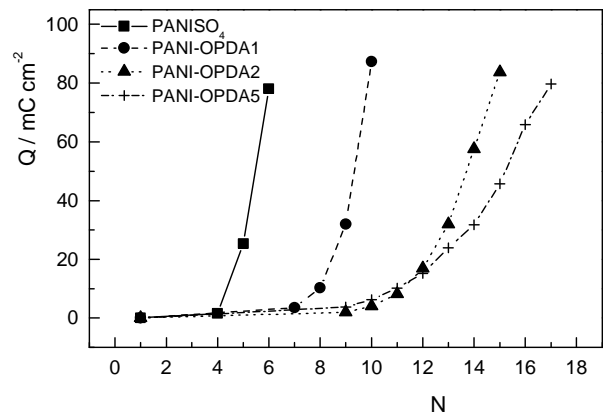


Fig. 1. The rate of Q_{PANI} increase vs. the number of cycles (N) for PANI coating synthesis in 3 M H₂SO₄.

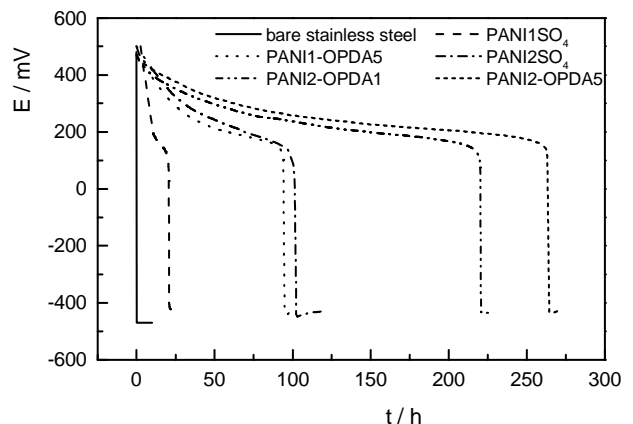


Fig. 2. E_{oc} vs. time for stainless steel coated by PANI in 3 M H₂SO₄.

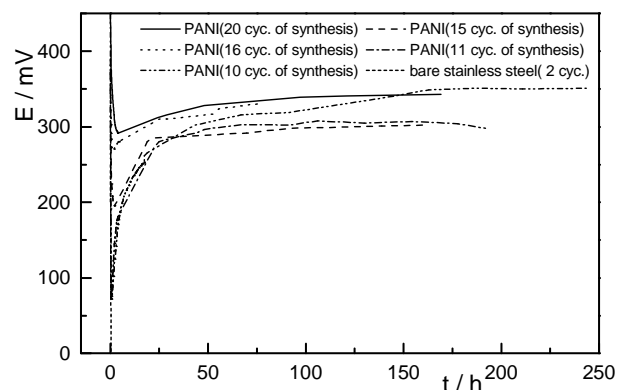


Fig. 3. E_{oc} vs. time for stainless steel coated by PANI of different thickness (cycles of synthesis $N=10-20$).

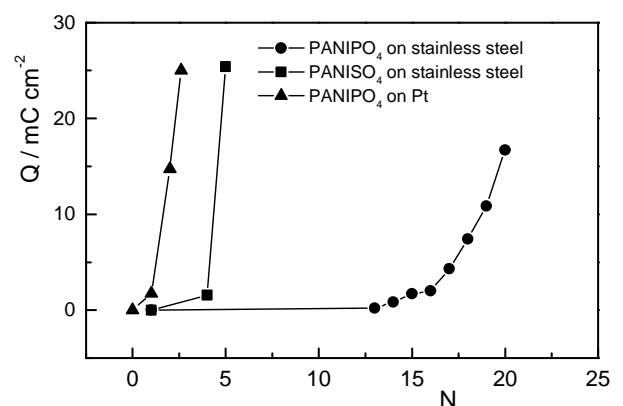


Fig. 4. A comparison of the rate of Q_{PANI} increase vs. number of cycles (N) for PANI coating synthesis.