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Electrochemical and Anticorrosive Properties of Polyaniline-based Self-doped Composites Electrodeposited on Stainless Steel †

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Abstract: Polyaniline (PANI) and its derivatives are characterized as multifunctional smart coatings due to their possible interaction with the environment and their unique properties, such as intrinsic conductivity. However, the conductivity of PANI decreases drastically at pH>4. To overcome this, ring-sulfonated PANI is synthesized, where the group $–SO_3H$ is attached to the polymeric chain may retain the electrochemical activity in high pH (~8), benefiting from the internal proton storage capacity [1]. Such self-doped PANI can be synthesized by the copolymerization of aniline (ANI) with its sulfonated derivatives. Poly-aniline-co-4-aminobenzensulfonic acid (sulfanilic acid, SA), shortened as P(ANI-co-SA), was found to exhibit excellent anticorrosive properties in chloride-free acid solutions [2] in contrast to chloride-containing acid ones. However, P(ANI-co-SA) thin films exhibit improved anticorrosive performance in neutral 0.5 M NaCl by inhibiting Cl^- to reach the SS substrate. A drawback of P(ANI-co-SA) is its lower conductivity. Thus we tried in this study to increase the electrochemical activity by doping the copolymer with Ni(II) [3]. This was carried out by one-step electrodeposition on SS via the addition of different concentrations of $NiSO_4.7H_2O$. The electrochemical and anticorrosive properties of Ni(II)-doped P(ANI-co-SA) films on SS were investigated by cyclic voltammetry and EIS in comparison with the corresponding Ni(II)-free P(ANI-co-SA) and pure PANI synthesized from sulfate solutions of the same pH (=3.23) with that of the copolymerization mixture. The morphology of films and their composition were characterized by using SEM coupled with EDX. The Ni(II)-doped P(ANI-co-SA) films exhibit a more compact structure, enhanced electrochemical activity in acid and neutral media, and protect SS against pitting corrosion during long-term immersion in 0.5 M NaCl.

Keywords: self-doped polyaniline; Ni(II)-doped sulfonated polyaniline; stainless steel.

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Conflicts of Interest

The authors declare no conflict of interest.

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