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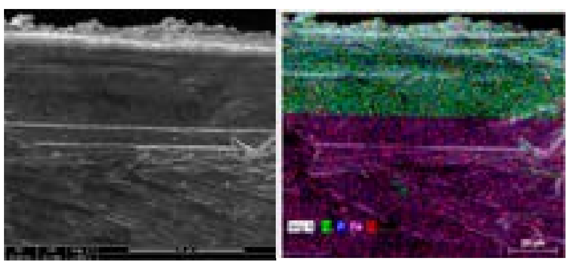
Anti-corrosion and Anti-bacterial Novel electroless NiP-TiNi Nanocomposite Coating

Pipelines move nearly 75% of the oil transported annually worldwide since they are efficient and environmentally friendly compared to other transportation means. Erosion and corrosion of the oil and gas pipelines are serious problems that lead to disastrous failure and damage to life and the environment. In addition, the bacteria and microorganisms that present in the seawater attached themselves to the surfaces of the pipeline, colonize, proliferate and finally form biofilm, which change the electrochemical behavior of the metal causing what is called bio-corrosion. The global cost of such failures is in the billions of dollars annually. Therefore, there is an increased need for the development of strategies to combat such failures. Superior protective coatings, including electroless plated ones, are the common methods for protecting oil and gas pipeline steels for their unique combination of properties such as wear and corrosion resistance, anti-bacterial properties as well as hardness. The electroless NiP-TiNi nanocomposite coatings are successfully electroless deposited on API X100 steel surface from an acidic electroless NiP plating solutions containing different concentrations of TiNi nanoparticles (0.2, 0.4 and 0.8 g/L). The morphology, thickness and elemental composition for the nanocomposite coatings were investigated by scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy. The nanocomposite coatings were heat-treated at 400 oC for 1 hour. The phase structure, roughness and hydrophobicity of the as-plated and heat-treated coatings using X-ray diffraction, atomic force microscopy and contact angle measurements, respectively, were investigated. Effect of the different nanoparticle concentrations in the plating bath on the micro-hardness and corrosion resistance of the as-deposited and the heat-treated coatings were evaluated. The results indicated that the TiNi nanoparticles are distributed uniformly in the NiP matrix, as shown in Figure1. Furthermore, the micro-hardness of NiP coating is enhanced about 22% by incorporation of 0.2 g/L TiNi nanoparticles and further enhancement is done by both anneal the nanocomposite coating and increase the TiNi concentration, as shown in Figure 2. While further increasing the concentration of TiNi nanoparticles and annealing the coating reduces the corrosion resistance, as shown in Figure 3. The NiP-TiNi nanocomposite coating has effective anti-bacterial properties as it decreased the cell viability of E. coli from 100 % to 30%.

Figure1: Cross-sectional SEM and EDX mapping of the cross-section image of the electroless NiP-0.2 g L-1 TiNi nanocomposite coatings.



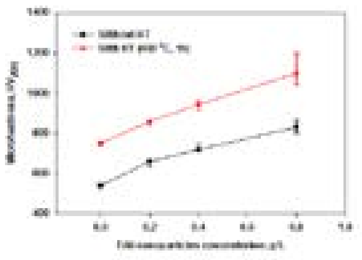


Figure 2: The microhardness of the NiP coating and NiP-TiNi nanocomposite coatings with different TiNi nanoparticles concentrations of 0.2, 0.4 and 0.8 g/L before and after heat treatment at 400 oC for 1 h

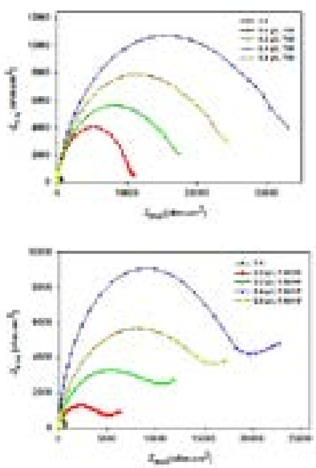


Figure 3: Nyquist plots of the substrate (CS), NiP and NiP-TiNi nanocomposite coatings with different TiNi concentrations (0.2, 0.4 and 0.8 g/L) in 3.5 wt % NaCl solution at room temperature before (lift) and after (right) heat treatment at 400o for 1h.

Biography

Aboubakr Moustafa Abdullah working at Qatar University, Qatar .He has published numerous research papers and articles in reputed journals and has various other achievements in the related studies. He has extended his valuable service towards the scientific community with his extensive research work

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