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ORIGINAL PAPER

Conducting polyaniline/multi-wall carbon nanotubes composite paints on low carbon steel for corrosion protection: electrochemical investigations

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The coaxial coating of multi-wall carbon nanotubes (MWCNT) with poly(aniline) (PANI) was synthesised and a paint was prepared containing conducting PANI–MWCNT composite. The corrosion protection performance was assessed by open circuit potential measurements, potentiodynamic polarisation, and electrochemical impedance spectroscopy. The corrosion rate of low-carbon steel coated with 1.5 mass % of PANI–MWCNT-based paint in 3.5 mass % sodium chloride solution was found to be 0.037 mm y^{-1}, about 5.2 times lower than that of unpainted low-carbon steel and 3.6 times lower than that of epoxy painted steel.

Keywords: corrosion, polyaniline, conducting polymer, carbon nanotubes

Introduction

Metals and alloys corrode in the environments encountered during their use. Corrosion, being an electrochemical phenomenon, can be countered by the use of electrochemistry and conducting polymers (Ahmad & MacDiarmid, 1996). Among conducting polymers, poly(aniline) (PANI) has been the subject of frequent studies in respect of corrosion protection. Poly(aniline) is prepared in as an emeraldine salt (Stejskal & Gilbert, 2002), in which form it is green and conducting. It can be oxidised electrochemically or by chemical oxidants to pernigraniline (Stejskal et al., 1996) or similarly reduced to leucoemeraldine. Due to its capacity to be both oxidised and reduced, PANI can take part in various redox processes or it can affect them. This applies also to those redox processes associated with the corrosion of metals and alloys.

PANI has other specific features to be considered in respect of corrosion. PANI is conducting, the typical conductivity being of unity of S cm^{-1} (Stejskal & Gilbert 2002). This means that, unlike insulating fillers, the transfer of electrons from reductant to oxidant can be mediated through the body of PANI, and reductant and oxidant molecules can react without the need to meet each other (Kalendová et al., 2008b). The electroneutrality is maintained by the transfer of protons because, unlike inorganic semi-conductors and metals, PANI is also a proton conductor (Stejskal et al., 2009).

The variability of PANI nanostructures that include nanofibres and nanotubes (Stejskal et al., 2010) and the broad selection of organic and inorganic acids that produce salts with PANI provide a broad range of materials differing widely in their electrochemical properties. It should be stressed that, while PANI always affects the corrosion behaviour, its effect is not necessarily always be positive, albeit positive results pre dominate. A conducting PANI coating on metals or alloys can be readily obtained using electrochem-

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