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Anti-corrosion performance of nanohybrid polyaniline on mild steel

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Corrosion is a natural process that has troubled human beings ever since the use of metals. Hence, efforts to develop more efficient and environmentally compliant methods to prevent corrosion have been ongoing throughout this century. Polyaniline (PANI) is found to be the most promising materials in corrosion protection [1] and it is because of their ease of synthesis, high electrical conductivity, nontoxic property, good environmental and chemical stability, chemical redox reversibility and low cost. It has been reported that PANI based coatings can prevent corrosion even in scratched areas where bare steel surface is exposed to the aggressive environment and thereby, effectively replace the toxic chromium (VI) containing coatings. The anti-corrosion performance of PANI also depends on the metal substrates and the coating formulation. PANI is also insoluble in water, sparingly soluble in organic solvents such as m-cresol and N-methylpyrrolidone (NMP) and non-fusible even by heating up to their decomposition temperature. A well-known technique of metal coating is to spread the suspensions of micro particles on the large metal surface and to dry them, like painting. To improve the anti-corrosion performance of PANI, various nanoparticles like titanium oxide (TiO_2), layered silicates and graphene are used within PANI network. Recently, hydrophobic and atomically thin layered nanomaterials such as graphene or h-BN have proven their effectiveness in metallic corrosion resistance. Nano boron nitride bears many novel properties, like high melting and decomposition temperature, thermal conductivity, chemically inertness, oxidation resistance, limited surface activity, non-wettability and lubricating effect [2,3].

In present study, a facile and effective dilution polymerization route was adopted to prepare micro-scale hierarchical three dimensional PANI@BN nanohybrids with a surface textured similar to that of Aloe-vera leaves. As-synthesized samples were characterized by using FTIR, XRD, FESEM, HRTEM (Figure 1), UV-Visible absorption and TGA/DTG. The hydrophobic nanohybrids with extremely rough surface offered a high barrier for the penetration of moisture and corrosive environments. Potentiodynamic polarization measurement of PANI@BN coated steel showed the large shifting in corrosion potential to the anodic region with respect to pure PANI. The corrosion inhibition efficiency (IE%) of PANI@ BN coating on mild steel in 3.5 wt% of NaCl, 1 M HCl and 1 M H_2SO_4 are calculated from the respective tafel plots and the calculated values were 98.25%, 90.93% and 99.30% respectively. The higher IE% of the synthesized nanohybrids indicated the superior anti-corrosion performance on mild steel due to synergistic effect between PANI and BN nanoparticles. The enhanced efficiency was attributed to an insulating interfacial layer formed by PANI@BN coating on mild steel.

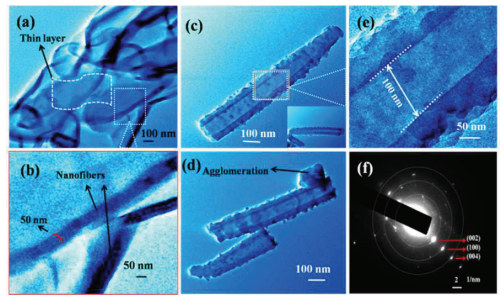

Figure 1: HRTEM images of (a, b) PANI and (c, d, e) PANI@BN nanohybrids; (f) SAED pattern of PANI@BN nanohybrids.[4]

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