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Synergistic Effect of Carbonaceous Reinforcements on Microstructural, Electrochemical, Magnetic and Tribological Properties of Electrophoretically Deposited Nickel

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Abstract

Mutilation of various industrial devices like rechargeable-batteries, magnetic-recording heads from corrosion and wear can be protected by carbon coatings on nickel surface. This article presents a comprehensive study of the corrosion, magnetic and tribological behaviour of electrophoretically deposited Ni with the carbonaceous composites, i.e. diamond (Ni-D), carbon nanotubes (Ni-CNT) and graphene (Ni-Gr). Enhanced corrosion resistance of Ni-D coating (1920 Ω cm^2) than that of pure Ni (552 Ω cm^2) and permanent magnetism with higher magnetic coercivity (413.56 Oe), compared to that of Ni-CNT (132.91 Oe), Ni-Gr (124.63 Oe) and pure Ni (129.07 Oe) coatings, is linked through the interfacial anchoring via distribution of the reinforcements. Enhanced magnetic coercivity and remanence of Ni-D coating is attributed to a wider domain wall width (1.65 µm) which has enhanced magnetostatic energy per unit area near the surface (3.16 erg/cm^2) compared to that of CNT (2.25 erg/cm^2) and graphene (0.94 erg/cm^2). Moreover, compressive stress (-611 MPa) existing in Ni-D coating have shown to seal the micro-cavities restricting the onset of corrosion and wear. With an enhanced corrosion resistance, magnetism and frictional resistance (reduced coefficient-of-friction, scratch wear volume and high scratch hardness), Ni-D coatings can be effectually applicable for batteries, marine, automotive and aerospace industries.

Keywords: Electrophoretic deposition; Ni-coatings; carbonaceous reinforcements; magnetism; corrosion resistance.

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