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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 ( $1920 \Omega \text{ cm}^2$ ) than that of pure Ni ( $552 \Omega \text{ cm}^2$ ) 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  $\mu\text{m}$ ) which has enhanced magnetostatic energy per unit area near the surface ( $3.16 \text{ erg/cm}^2$ ) compared to that of CNT ( $2.25 \text{ erg/cm}^2$ ) and graphene ( $0.94 \text{ erg/cm}^2$ ). 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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