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EFFECT OF HEAT TREATMENT TEMPERATURE AND DURATION ON THE TRIBOLOGICAL PERFORMANCE OF ELECTROLESS NI-P COATING AND ITS COMPARISON WITH NI-P-W AND NI-P-CU COATINGS

Abstract:

Electroless nickel (EN) coatings are suitable for various surface engineering applications particularly which require protection against wear and corrosion. The advantages of electroless technique is that the coating is uniform and can be deposited over intricately shaped objects made of any material. Besides, the coating is inherently hard, wear resistant and corrosion resistant and can be further customized by suitable thermal processing or by incorporating a third element. The present work takes a cue from this and attempts to assess the effect of heat treatment temperature as well as heating period on hardness and tribological behavior of high phosphorus enriched electroless Ni-P (□12 % wt. P), Ni-P-W (□5.3 wt.% W) and Ni-P-Cu (□16 wt.%Cu) coatings. All the three coatings are deposited on mild steel substrates and heat treated to 400°C for 1h and 4h duration. Phase transformation temperature (PTT) of the coatings are determined by DSC (Differential Scanning Calorimetry) and they are found to lie in between 330-370°C. The coatings (both as-deposited and heat treated) are further characterized by energy-dispersive X-ray analysis (EDX), X-ray diffraction (XRD) and scanning electron microscopy (SEM). All the coatings are found to display the typical nodular morphology common to most EN coatings. Heat treatment temperature together with heating periods has profound effect on coating microstructure. Ni-P-W shows relatively higher hardness (Vickers's) in as-deposited condition (616HV100) which further increases upon heat treatment. However, the maximum hardness is displayed by Ni-P coating (1347HV100) when heat treated at 400°C for 4 h. Heat treatment resulted is precipitation of harder nickel phosphide phases which increased the overall hardness of the coating. Prolonged heating at a constant temperature again resulted in diffusion of iron (from substrate) as well as oxide formation on the coating surface. In case of friction and wear evaluation, Ni-P-W exhibited the highest wear resistance when processed at 400°C for 4 h. Both heat treatment temperature and duration is also found to influence the tribological behavior of the coating. At longer heat treatment cycle under higher temperature, the friction and wear behavior of the coatings is governed by the formation of mechanically mixed layer of oxides, inter diffused iron and phosphides. The wear mechanism is also investigated by SEM of the coated samples post tribological test and is found to be both adhesive and abrasive in nature.

Keywords:

electroless, heat treatment, friction, wear, hardness