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Abstract

The main objectives of this Ph.D. research work are the development of enhanced metal matrix nanocomposite coatings through gas carburizing of electrodeposited nanocrystalline and amorphous alloy precursors. The carburizing environment was created by introducing a flowing mixture of vaporized 95.5% alcohol (0.25 ml/min, liquid) and argon (0.5 L/min, gas) into the carburizing furnace. Six different alloy coatings namely Ni-W, Co-W, Co-Ni-W, Fe-W and Fe-Ni-W with tailored microstructure obtained by controlling the process parameters like current density, pH and temperature were synthesized. The *in-situ* carbide formation of binary and/or ternary carbides has been obtained in the bcc/fcc matrices. In Ni-WC composite coatings, WC is formed in the FCC Ni matrix. The size of the carbide particles ranges between 100 and 500 nm. TEM study has revealed the presence of carbide phase in the form of very small precipitates inside the Ni grains, the size of such precipitates is between 10 and 40 nm. The Co-W and Fe-W electrodeposited alloy coatings are not much adherent at high deposition current densities, incorporation of Ni increased the adhesion and compactness of the coatings.

The carbides of Co-Ni-W composite were needle like that at less carburizing time were at the top surface , while these were present at the depth also with increase in carburizing time as revealed by the section SEM images. Dendritic structure of carbides of Fe_3W_3C and WC were observed in Fe-W-C carbide composite coatings with the through thickness carbide formation.

The hardness of the composite coatings was found to increase with the tungsten content and the carburizing temperature. The maximum hardness of about 1200 KHN is achieved for Fe-Ni-W composite coatings.

Supersaturated nature of electrodeposited amorphous and nanocrystalline alloys, in addition to high diffusivity, have been attributed for the formation of carbide phases uniformly distributed in the matrix at a temperature range of 700–850° C.