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Mechanical Properties of Diamond Reinforced Ni Nanocomposite Coatings Made by Co-Electrodeposition with Glycine as Additive

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Abstract : Diamond-reinforced Ni matrix composite has been widely applied in engineering for coating large-area structural parts owing to its high hardness, good wear resistance and corrosion resistance compared with those features of pure nickel. The mechanical properties of Ni-diamond composite coating can be promoted by the high incorporation and uniform distribution of diamond particles in the nickel matrix, while the distribution features of particles are affected by electrodeposition process parameters, especially the additives in the plating bath. Glycine has been utilized as an organic additive during the preparation of pure nickel coating, which can effectively increase the coating hardness. Nevertheless, to author's best knowledge, no research about the effects of glycine on the Ni-diamond co-deposition has been reported. In this work, the diamond reinforced Ni nanocomposite coatings were fabricated by a co-electrodeposition technique from a modified Watt's type bath in the presence of glycine. After preparation, the SEM morphology of the composite coatings was observed combined with energy dispersive X-ray spectrometer, and the diamond incorporation was analyzed. The surface morphology and roughness were obtained by a three-dimensional profile instrument. 3D-Debye rings formed by XRD were analyzed to characterize the nickel grain size and orientation in the coatings. The average coating thickness was measured by a digital micrometer to deduce the deposition rate. The microhardness was tested by automatic microhardness tester. The friction coefficient and wear volume were measured by reciprocating wear tester to characterize the coating wear resistance and cutting performance. The experimental results confirmed that the presence of glycine effectively improved the surface morphology and roughness of the composite coatings. By optimizing the glycine concentration, the incorporation of diamond particles was increased, while the nickel grain size decreased with increasing glycine. The hardness of the composite coatings was increased as the glycine concentration increased. The friction and wear properties were evaluated as the glycine concentration was optimized, showing a decrease in the wear volume. The wear resistance of the composite coatings increased as the glycine content was increased to an optimum value, beyond which the wear resistance decreased. Glycine complexation contributed to the nickel grain refinement and improved the diamond dispersion in the coatings, both of which made a positive contribution to the amount and uniformity of embedded diamond particles, thus enhancing the microhardness, reducing the friction coefficient, and hence increasing the wear resistance of the composite coatings. Therefore, additive glycine can be used during the co-deposition process to improve the mechanical properties of protective coatings.

Keywords : co-electrodeposition, glycine, mechanical properties, Ni-diamond nanocomposite coatings
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