Electrochemical Synthesis of Nickel-Based Composite Materials Modified with Nanosized Aluminum Oxide

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Abstract: Electrochemical synthesis of nickel-based composite coatings and foil reinforced with nanosized aluminum oxide is reported. Ni-Al₂O₃ composites with different content of the modifying phase were prepared by chemical dispersion of aluminum oxide using the “from above down” principle. The influence of the aluminum oxide concentration in the electrolyte on the physicomechanical properties of the reinforced foil was determined. Incorporation of reinforcing phase particles into the metal matrix leads to a decrease in the grain size and enhances by a factor of 2–6 the strength characteristics of the coatings and foil. The topography of the surface and the cross section profile of the composites were examined, and the influence of these characteristics on the properties of the materials was determined.

Preissteten results of electrochemical synthesis of nickel-based composite coatings and foil reinforced with nanosized aluminum oxide is reported. Ni-Al₂O₃ composites with different content of the modifying phase were prepared by chemical dispersion of aluminum oxide using the “from above down” principle. The influence of the aluminum oxide concentration in the electrolyte on the physicomechanical properties of the reinforced foil was determined. Incorporation of reinforcing phase particles into the metal matrix leads to a decrease in the grain size and enhances by a factor of 2–6 the strength characteristics of the coatings and foil. The topography of the surface and the cross section profile of the composites were examined, and the influence of these characteristics on the properties of the materials was determined.

Presented results of electrochemical synthesis of composite coatings and foils on the basis of nickel, reinforced with nanosized aluminum oxide. For the preparation of composites Ni – Al₂O₃ with different content of modifying phase used chemical dispersion of aluminum oxide in the electrolyte on the principle of from the top to the bottom. It was established that the concentration of aluminum oxide in the electrolyte affects the properties of the reinforced foil. Incorporation of reinforcing phase particles into the metal matrix leads to a decrease in the grain size and enhances the strength properties of the materials by a factor of 2–6. The topography of the surface and the cross section profile of the composites were examined, and the influence of these characteristics on the properties of the materials was determined.
The development of novel materials and processes requires the implementation of various techniques to achieve improved mechanical properties. Composite coatings, such as nickel-phosphate, offer significant improvements in tribological performance due to their unique combination of properties. These coatings can be tailored to enhance friction, wear, and corrosion resistance, making them suitable for a wide range of applications. The coating process involves a series of steps, including pretreatment of the substrate, deposition of the coating, and post-treatment to optimize the coating's properties.

In this study, we investigated the microstructure and mechanical properties of nickel-phosphate coatings deposited on various substrates using a novel chemical bath deposition (CBD) technique. The coatings were characterized using X-ray diffraction (XRD), scanning electron microscopy (SEM), and hardness testing. The results showed that the coating thickness and hardness were significantly influenced by the deposition parameters, such as temperature and pH. Furthermore, the corrosion resistance of the coatings was evaluated using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) techniques.

The mechanical properties of the coatings were found to be comparable to those of commercial Ni-P coatings, indicating the potential of this novel deposition technique for industrial applications. The findings of this study suggest that further optimization of the deposition parameters could lead to the development of coatings with even better performance.

**Keywords:** Nickel-phosphate coatings, Chemical bath deposition, Microstructure, Mechanical properties, Corrosion resistance.

**References:**


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