Research Article

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Study the effect of adding zirconia particles to nickel–phosphorus electroless coatings as product innovation on stainless steel substrate

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Abstract: Scholars have spent much time studying metal deposition procedures involving the deposition of electroless nickel, alloy, and composite coatings on various surfaces; the most current uses were feasible advantages of the coatings' many good properties for achieving the final product innovation. Lately, these coatings have demonstrated intriguing wear and corrosion resistance features, resulting in several innovative macro-level developments. The notion of composite coating by co-deposition coating has been presented in this article. The characteristics of Ni–Pb alloy coatings were examined by inserting particles into the electroless deposited solution. The stainless steel (SS) specimens have been electroless coated with Ni–Pb and ZrO_2 nanoparticles (size = 30–70 nm) at 0, 10, and 20 g/L amounts. The materials have been examined using scanning electron microscope and atomic force microscope, followed by wear-resistant and microhardness testing. According to the investigation findings, including inert particles improved the hardness magnitude and wearing resistance considerably. The base metal exhibited the highest wear rate at 10 N, while thewear rate decreased in the Ni–Pb–ZrO_2-coated SS316L by 34%. The Vickers hardness magnitudes of the Ni–Pb–ZrO_2-coated samples at different ZrO_2 contents (0, 10, and 20 g/L) were 19, 50, and 81%, respectively.

Keywords: composite coating, electroless nickel–phosphorus, product innovation, stainless-steel, zirconia, wear-resistant, micro-hardness test

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1 Introduction

Electroplating is commonly considered the traditional electrolytic plating process. It is achieved when metal ions are first reduced to their respective metallic states before deposition at the cathode under an external electrical source [1]. Electroless plating can be likened to a chemical reduction process in many aspects, even though they differ significantly. It includes the catalytic decrease of metallic ions in a reducing agent-containing aqueous solution, followed by the subsequent deposition of the metal without any external energy source [2–7].

Electroless Ni–P/Ni–B coatings offer a wide range of applications in sectors that demand high hardness and anti-corrosion rates. The reason for such a thin layer of deposition is that the activated surface seems to be no longer in touch with the electroless solution after the metal is deposited. Because the deposited metal is in touch with the bath, no additional reaction can occur. As a result, at such a thin deposition thickness, it is critical to keep the surface roughness to a minimum, as this characteristic of the coating is linked to other characteristics, including wear and friction that also decrease coating life by subjecting the substrate to increased wear and corrosion, thereby increasing the price.

The chemical nickel reductions result in the formation of the electroless nickel deposit; however, this process depends on the reducing agent utilized. For instance, nickel-phosphorus coatings are produced when hypophosphite is utilized as the reducing agent [8]. Hence, the reaction must be controlled to ensure the reduction only