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Corrosion performance of electrospinning nanofiber ZnO-NiO-CuO/ polycaprolactone coated on mild steel in acid solution

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ABSTRACT

In the present work, PCL/ZnO (polycaprolactone/ zinc oxide), PCL/NiO (polycarprolactone/nickel oxide), PCL/CuO (polycarprolactone/copper oxide), and PCL/ZnO-NiO-CuO (polycarprolactone/ zinc oxide- nickel oxide-copper oxide) have been successfully fabricated and deposited on a mild steel through electrospinning technique. SEM, EDX, and FT-IR had been used to characterize all nanofiber coatings on the mild steel. A nanofiber layer of ZnO/NiO/CuO/PCL was utilized to coating the mild steel as a corrosion protector film in 1M HCl. A series of electrochemical techniques like Open circuit potential (OCP), Electrochemical impedance spectroscopy (EIS), linear polarization resistance (LPR), and potentiodynamic polarization (PDP) were used to analyse the anti-corrosion performance of the nanofiber layer ZnO/NiO/CuO/PCL. The results showed that both anodic and cathodic reactions sharp decline with shift in corrosion potential toward a positive direction in the Tafel plots. LPR results showed that the highest protection efficiency was 94.8% with ZnO-NiO-CuO/PCL nanofiber coating. EIS spectra showed that mild steel coated with ZnO/PCL, NiO/PCL, CuO/PCL, and ZnO-NiO-CuO/PCL, realization of capacitive conduct at high frequency and coating strength at law frequency part with resistor component 474.76 ohm.cm^2, 527.35 ohm.cm^2, 714.73 ohm.cm^2, 744.80 ohm.cm^2 respectively, indicating the good barrier properties and high ohmic resistance of coatings. SEM displayed a straight, interconnected structure, relatively less porosity with uniform fibers diameter. The fibers had average diameter 429 nm, 525 nm, 639 nm, and 443 nm for ZnO/PCL, NiO/PCL, CuO/PCL, and ZnO-NiO-CuO/PCL respectively. EDX and FT-IR results confirmed the existence of ZnO, NiO, and CuO and approved the distribution into PCL matrix. . Results of the present study confirmed that ZnO-NiO-CuO/PCL electrospinning nanfiber coating could be considered as a new metallic oxide nanocomposite coating for a mild steel with excellent corrosion resistance.

1. Introduction

Corrosion of metals still plays a significant role to deterioration the efficiency and losses of the life [1–4]. Tens of billions of damages can be incurred every year by corrosion of steel material [5], as everyone knows. Taking protection on the metal surface is one kind of the economic approach, which can result in avoiding tens of billions of losses per annually [5]. The protective cover of the metal surface is an economically efficient and commonly used form of corrosion prevention [5,6]. Due to their cost-effectiveness, carbon steel is widely used for the construction of marine structures [7]. Steel has been a significant part of our lives because of its comprehensive applications in the automobile, domestic products, company machinery and heavy construction market, such as marine and chemical industries. However, steel corrosion has given us many issues, such as resource loss, breakdown of facilities and environmental pollution [8,9]. Because of the certain mechanical performance and machine strength, mild steel is preferred for infrastructure at low cost and certain time; it should be tried to resist against corrosion occurrences. This reality is among the main triggers of industrial incidents and natural resource use [10]. The most inexpensive and

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