REDUCING THE IMPACT OF CORROSION USING NAMOMATERIAL COATING

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ABSTRACT

In this paper, we try to give suggestion to prevent the corrosion of oil pipes using nanomaterials to produce high-performance coatings, for example alloy of Zn-Ni-Al2O3 nanocomposite coatings. The study of coating properties of such alloy is very important in order to obtain a high quality coating on mild steel. The effect of alumina nanoparticles on the structural properties of Zn-Ni-Al2O3 alloy for improved resistance against corrosion of this alloy coating was investigated. Thus mechanical properties will improve.

Keywords: Nanotechnology, nanoparticles  alloys

INTRODUCTION

Nanomaterials are important due to their unique properties that may lead to new and exciting applications [1]. Nanotechnology has a potential applicability in the field of protecting metals against corrosion, which has been attracting a wide attention of researchers. Nanostructure particulates can be adopted to suppress corrosion taking place as a result of the surrounding environment condition. It can use effectively some alternatives to hazardous and toxic compounds such as nanocomposites [2]. As a new technique in nanotechnology applications is nanocoating which is mainly adopted for avoiding and controlling corrosion protection.
According to the fact that the physical, chemical and physicochemical properties are unique and crucial, nanocoating technology has a remarkable contribution in this field. In nanocoating, some specific features can be enhanced due to incorporation of nanoparticles in the coating formulation [3]. The disintegration of metal/alloys surfaces due to specific environmental circumstances is known as corrosion [4]. Corrosion healthy in equipment of big industries such as oil industries as well as the quality of its transmission is an important and basic problem which disregarding of this phenomenon causes to stop production and consequently cost repairing [5]. The improvement of the lifespan and performance of metallic alloys and components through the application of numerous anti-corrosion coatings is highly advantageous [6].

1. **Experimental Details**

Mild steel sheet was used as substrate with 1 mm in thickness and an area of 20 cm², also was used as the cathode, while a high purity (99.75%) nickel plate was used as the anode. Substrates must be thoroughly cleaned before deposition, and a variety of procedures exist for this purpose. The compositions bath were (was) ZnSO₄·7H₂O, NiSO₄·6H₂O and NaSO₄. In the bath, Al₂O₃ concentration were (0, 25, 50 gm. L⁻¹) in order to obtain Zn–Ni electrodeposition, while the processing parameters were; time (20 minute), current density (60 mA/cm²) and agitation speed 400 rpm. The pH of the bath was adjusted to 3 ± 0.5 using a dilute H₂SO₄ solution. After the bath preparing, then cathodes immediately immersed in plating bath to deposit nanocomposite coating.

1. **RESULTS AND DISCUSSION**

3.1 **XRD ANALYSIS**

Figure 1 shows XRD pattern of Zn–Ni composite coatings for three cases (0, 30, 50 gm. L⁻¹) of concentration of Al₂O₃. The main peak corresponding (330) dominated for all cases with phase structure is single (γ-Ni₅Zn₂₁). The peak broadening suggested the formation of nanocrystals of size and the prominent peak of any one of each spectra confirm that the synthesized particles have a crystalline structure with random crystal orientation. As seen, there are small peaks appear in the XRD pattern. Using Deby-Scherrer formula:

$$D_{hkl} = \frac{k \lambda}{\beta \cos \theta} \ldots \ldots \ldots (1)$$

The average grain size of the prepared samples can be calculated from the prominent peak (330), λ- X-ray wavelength, β- FWHM (full width at half the peak maximum) [7]. The grain size of Zn–Ni coating is larger than the grain size of Zn–Ni–Al₂O₃ coatings. If the concentration of Al₂O₃ increases from 25 to 50 gm. L⁻¹, the grain size decreases from 48 to 29 nm. Smaller grains on the nanometer in the fine structure can increase microhardness [8].

1.2 **SURFACE MORPHOLOGY**
Figure 2 shows the images of the atomic force microscope in two dimensions and three dimensions with different concentrations of Al₂O₃, (0, 25 and 50 gm/l). It can be concluded from the images, the greater amount of Al₂O₃ will lead to increased refinement of crystal size, this may be due to incorporation of Al₂O₃ nanoparticles in the Zn–Ni coating.

Figure 1: X-ray diffraction patterns of Zn–Ni alloy coatings with two different concentrations of Al₂O₃:
    (a) Zero (gm/l), (b) 25 (gm/l), and (c) 50 (gm/l).
Figure 2: Two and three dimensions images of Zn–Ni alloy coatings with different concentrations of Al₂O₃: (a) Zero, (b) 25, and (c) 50 (gm/l).

3.3 MICROHARDNESS OF THE COATING

Using a Vickers hardness tester (HV) and at constant time of 15 second to load of 100 g, the microhardness of coatings were measured and performed in (on) the surface by using a Wolpert Wilson Instruments (model 402UD) [9]. The results obtained from microhardness test of Zn-Ni and Zn–Ni–Al₂O₃ with respect contents of nano-alumina in the composite coatings are (is) shown in figure 3. It is clear that the hardness increase as the alumina concentration increase.
Figure 3: Hardness of Zn-Ni and Zn–Ni–Al₂O₃ as a function of Concentrations of Al₂O₃

CONCLUSIONS

The incorporation of Al₂O₃ nanoparticles with Zn-Ni alloy, lead to improves the structure of Zn–Ni–Al₂O₃ alloy. The grain size decreases from 48 to 29 nm as the content of Al₂O₃ increases from 25 to 50 (gm/l) and the surface morphology becomes more refined of crystal size, while hardness increase as the alumina concentration increase.

REFERENCES


