11 th International Conference on Innovation and Research in Engineering Sciences
GEORGIAN INTERNATIONAL ACADEMY OF SCIENCES AND STUDIES
10 March 2022 -TBILISI GEORGIA
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Effect of current density on the morphology and chemical composition of Ni-Co/Ni-P-SiC coatings

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***Abstract*— This study aims to evaluate the effect of current density on the surface morphology and chemical composition of the Ni-Co/Ni-P-SiC coatings. The coatings were direct current (DC) electrodeposited on the St 37 steel. The current density is varied in the range of 1-4 A/dm^2. Scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS) were used to evaluate the surface morphology and constituent elements, respectively. Results showed that the increase in current density alters the morphology of the particles and the size of the grains. It also determines the weight percent of the co-deposited SiC particles. The highest amount of included particles is obtained at 3 A/dm^2.**

I. INTRODUCTION

Recently, the electrodeposition method has been attracted a best attentions thanks to its unique features including simplicity, low cost, and excellent industrialization level. Ni-Co alloy coatings have been the main focus of many literatures due to their specific magnetic properties, desirable resistance to wear and corrosion, resistivity against high temperature oxidation, as well as acceptable mechanical properties. The concept of preparation of duplex coatings via electrochemical methods including electrodeposition and electroless received tremendous attention during last decades [1-4].

St 37 is a non-alloy steel which has been mainly used to riveting, bolting, and welding proposes for building ships and bridges. However, its poor mechanical properties e.g. hardness coupled with low wear resistance have restricted its industrial applications [5, 6].

In this work, the effect of current density on the surface morphology and chemical composition of the Ni-Co/Ni-P-SiC coatings is addressed.

II. MATERIALS AND METHODS

Ni plate (40×20 mm^2) and rectangular St 37 steel sheet (20×10 mm^2) were utilized as anode and cathode, respectively. The substrates were mechanically polished using 100 to 3000 grit silicon carbide papers. A final polishing operation conducted by nano alumina particles. The polished substrates were immersed into the dilute NaOH solution which was kept at 60 ^{o}C for 3 min in order to remove the impurities and greases. The bath composition used for electrodeposition of the coatings are listed in Table 1.

TABLE I. THE BATH COMPOSITION USED FOR ELECTRODEPOSITION OF THE COATINGS

Solution composition	*Concentration (g/L)*
$NiSO_4.6H_2O$	250
$NiCl_2.6H_2O$	40
H_3BO_3	40
$CoSO_4.7H_2O$	50
$NaC_{12}H_{25}SO_4$	0.35
Nano SiC	10

Surface morphology of the nanocomposite coatings were characterized using scanning electron microscope (Vega Tescan, Czech Republic) equipped with energy dispersive spectrometer (EDS). EDS analysis was employed in order to