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THE INFLUENCE OF THE HEAT TREATMENT UPON THE RESISTANCE TO CORROSION OF THE COMPOSITE OBTAINED USING THE ELECTRODEPOSITING OF TiO_2 IN A NICKEL MATRIX

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ABSTRACT

The resistance to corrosion of a composite material obtained using the electro-depositing of TiO_2 in a nickel matrix subjected to heat treatment was studied using the galvanostatic method; the samples were obtained by the electrodepositing of TiO_2 (60%) in a nickel matrix on a copper basis. A Watts electrolyte was used for the electrodepositing. The resistance to corrosion of a sample without composite layer was compared with the resistance to corrosion of a sample with a composite layer subjected to heat treatment.

KEYWORDS: composite coatings, nickel matrix, electrochemical depositing, TiO_2 particles.

1. Introduction

One of the methods by which we can obtain a composite material is electrodepositing.

The process of electrodepositing of the composite layers consists of including solid particles in a suspended state into a bath of electrolyte in the metal that electro-crystallizes and which constitutes the metallic matrix. These particles are considered insoluble. The electrochemical joint depositing cannot be regarded as an electrochemical process separated from the electrodepositing of the metal itself.

Generally speaking, the electrodepositing of a metal on a base material can have as goal the increase of the resistance to corrosion and the wear of the respective part or the improvement of the aspect of the part using decorative depositing.

2. Experiment

The electrodepositing of the composite layer was obtained using continuous current with the help of a potentiostat, measuring instruments and electrolytic cell.

The samples with a surface of 12 cm^2 were made from copper. For the electrodepositing a Watts electrolyte was used having the following composition:

- $NiSO_4 \cdot 7H_2O$.....250g/l
- $NiCl_4 \cdot 6H_2O$.....50g/l
- H_3BO_3 .....40g/l

The temperature of the electrolyte was 50±2ºC, pH 3, bustling 750 rot/min, the time for the electrodepositing being 120 minutes, the percentage of powder in the electrolyte is between 20-80%.

After the electrodepositing process the samples were dried and afterwards heat treated in a protected atmosphere with the following parameters:

- The temperatures used: 500ºC and 700ºC
- Time 60 minutes
- Furnace cooling

After the heat treatment the micro-strength of the deposited layer was measured and the resistance to corrosion using the Taffel curves was calculated.

3. Results and discussions

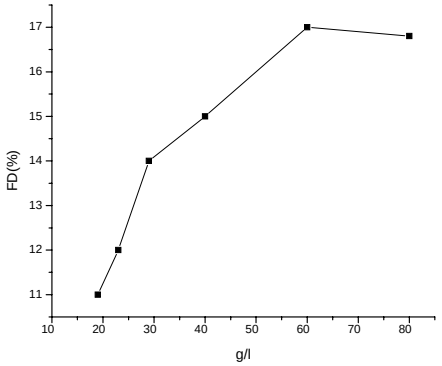

Fig. 1. *The variation of the dispersed phase in the composite layer depending upon its concentration in the electrolyte.*

By modifying the parameters of the electrodepositing there are obtained needle like shapes in which the percentage of the dispersed phase may vary according to Fig.1

3.1 The micro-strength

By using the above mentioned parameters of the electrodepositing it is obtained a composite layer of TiO_2 (17%) in the nickel matrix.
The heat treatment influences the deposited layer strength. The results are shown in the Table 1.

Table 1. *The variation of the micro-strength depending on the temperature of the heat treatment*

Sample	Micro-strength [HV_{50}]
Sample without composite covering	180-200
Untreated sample	400-420
Heat treatment at 500ºC	750-770
Heat treatment at 700ºC	530-550

It can be noticed an increase i the micro-strength in the case of the samples with electrochemical covering compared to those without covering and an increase of the micro-strength of the samples treated at 500ºC compared to the untreated samples; this increase is due to the difference between the expansion coefficient between the layer and the sub-layer which leads to the appearance of certain tensions in the deposited layer. The increase in temperature of the heat treatment at 700ºC leads to a decrease of the micro-strength of the samples.

3.2. Resistance to corrosion

The copper samples were covered using electrodepositing, subjected to heat treatment and afterwards it was checked the resistance to corrosion using electrochemical tests in a solution of NaCl 15%.

There were calculated for each sample the corrosion index and the penetration index; the results are presented in the table 2.

Table 2. *The parameters of the corrosion*

Sample	I_{cor}[mA]	I_p[mm/year]
Sample without compound layer	270	0.06856
Untreated sample	50	0.01325
Sample treated at 500ºC	125	0.04533
Sample treated at 700ºC	45	0.01279

It can be noticed that the maximum corrosion speed appears in the case of the samples without the compound layer. The sample treated at 700ºC has a better resistance to corrosion than the samples with treatment at 500ºC.

The corrosion behaviour of the two samples with heat treatment can be explained using:

- the presence of the heat tensions within the deposited layer
- it is well known the fact that the nickel has an inter-crystalline corrosion phenomenon in the interval 300ºC-500ºC[1].

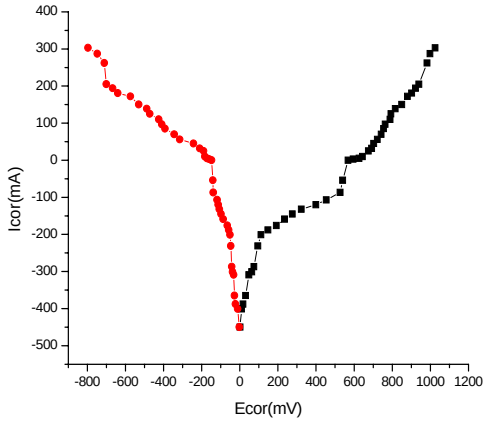

Fig. 2. *Taffel curves for the sample without heat treatment.*

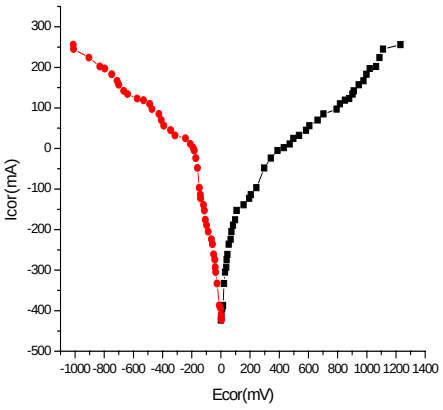

Fig. 3. *Taffel curves for the sample with heat treatment at 500ºC.*

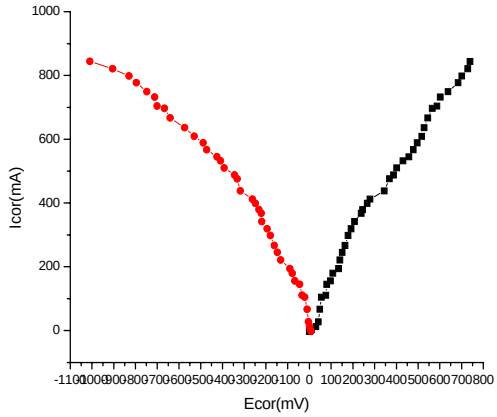

Fig. 4. *Taffel curves for the sample with heat treatment at 700ºC.*

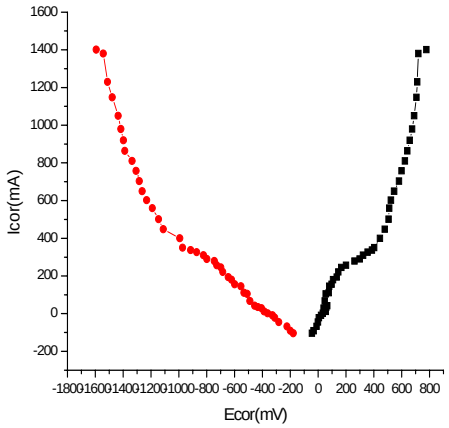

Fig. 5. *Taffel curves for the sample without composite layer.*

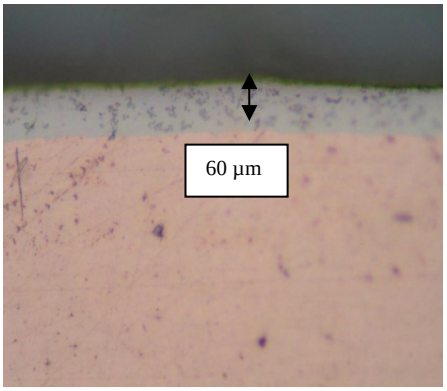

Fig.6. *The microstructure of the sample with composite layer (T=500ºC).*

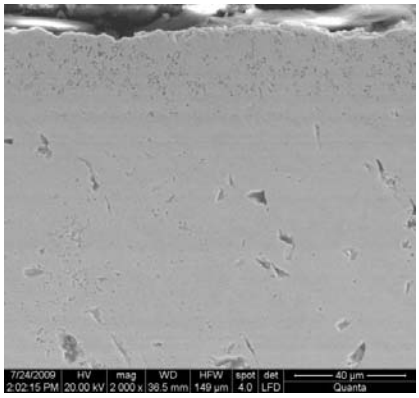

Fig.7. *SEM made for the sample with composite layer (T=500ºC).*

4. Conclusions

The heat treatment at temperatures of 500ºC determines an increase i the micro-strength of the deposited layer, but the composite has a corrosion resistance inferior to the samples treated at 700ºC.

The composite samples have a resistance to corrosion superior to the samples without composite layer.

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