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TRIBOLOGICAL PROPERTIES OF COMPOSITE MATERIALS OBTAINED USING ELECTRODEPOSITING

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ABSTRACT

The resistance to abrasive wear of composite materials obtained using electrodepositing in nickel and copper matrix was studied. The samples containing composite layers of graphite in copper matrix, titan dioxide and zirconium dioxide in nickel matrix were subjected to the wear process using a pin-disc type testing machine.

KEYWORDS: composite coating, tribological properties

1. Introduction

The tribology concept refers to the interaction between two or more bodies with one or more surfaces in contact, with or without macroscopic relative motion, in order to transmit normal or tangential forces. The process of friction-wear is a complex one, producing modifications in the geometry and structure of the superficial layers that are in contact with each other; this phenomenon leads to losses of material reducing the precision and the efficiency of machines and tools. In the automotive industry there are many parts affected by the wear which leads to the replacing of the traditional materials with composite materials (table 1).

Table1. *The use of composite materials in the automotive industry [1]*

System	Components	Improved Properties
Engine	Piston head; valve; piston bolt; rod; bearings	Resistance to high temperatures; weight; wear
Housing	Gearbox bearings	Weight; wear
Brake	Brake Disc	Weight; wear
Suspensions	Strut	Rigidity; resistance to wear

Good tribological properties are also seen in the case of composite coverings with metallic matrix obtained using electrodepositing; in the case of these composite materials the properties of the metallic matrix are improved by adding the disperse phase that is under the form of powder.

2. The experimental method

We studied the tribological behavior of many samples made using electrodepositing.

Table 2. *Characterization of samples depending on the nature of matrix and dispersed phase*

Sample	Matrix	Dispersed phase, (DP)	DP in the composite layer (%)	Layer thickness (μm)
G 25	copper	graphite	5	19
G40	copper	graphite	6	20
T35	nickel	TiO_2	11	18
T67	nickel	TiO_2	12	20
Z21	nickel	ZrO_2	7	30
Z45	nickel	ZrO_2	8	35

We deposited TiO_2 and ZrO_2 in nickel matrix and graphite in copper matrix. The size of the TiO_2 and ZrO_2 dispersed phases was 2-5µm and 8-15µm for graphite. All the electrodeposits were made on a copper basis.

The technological scheme was the following one: *Electrodepositing, Drying, Punching, Degreasing, Abrasive wear resistance testing.*

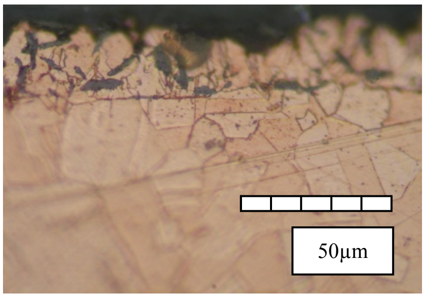


Fig. 1. *The microstructure of the sample G 40 before the wear testing (the basis is made of copper, matrix of copper and graphite is the dispersed phase)*

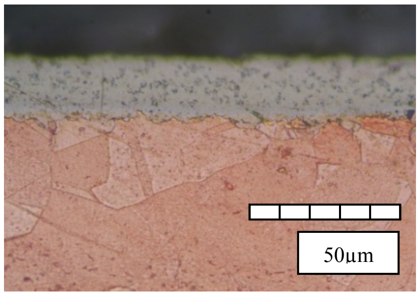


Fig. 2. *The microstructure of the sample T67 before the wear testing(the basis is made of copper, matrix of nickel and TiO_2 is the dispersed phase)*

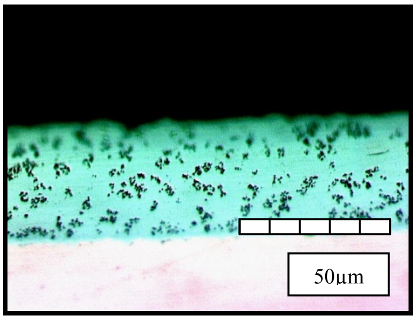
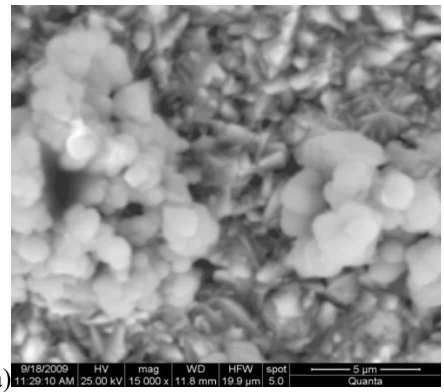
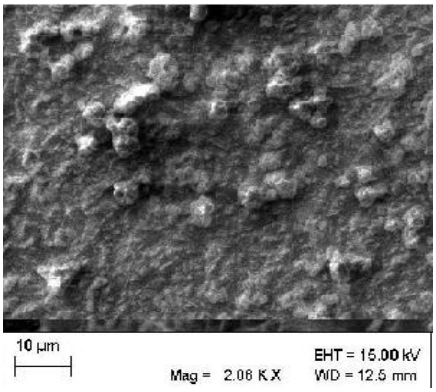


Fig. 3. *The microstructure of the sample Z45 before the wear testing (the basis is made of copper, matrix of nickel and ZrO_2 is the dispersed phase)*

a) 

b) 

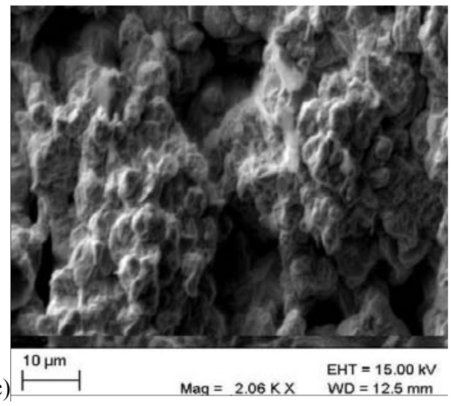
c) 

Fig. 4. *SEM micrograph of composite layers: a) Nickel-TiO_2 ,b) Nickel-ZrO_2 and c) Copper-graphite*

2.1 Abrasive wear resistance testing

The machine used in order to check the abrasive wear resistance is a pin-disc type one. The sample is introduced in a puncher that presses with a certain force upon a rotating disc covered with abrasive paper (600 granulation). The sample executes a spiraling motion on the disc with the help of a mechanism. All the samples were pressed against the disc with the same force and have traveled the same distance. At the end of the testing the mass loss of each sample was measured. The variation of the mass was established by weighing with a scale with the precision of $1x10^{-3}$ grams.

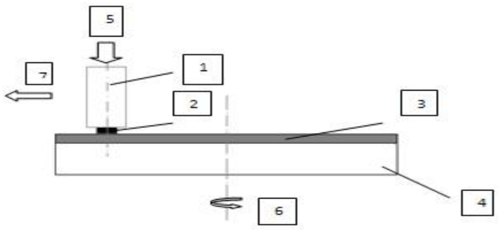


Fig. 5. *The scheme of the abrasive wear resistance testing machine: 1. puncher, 2. sample, 3. abrasive paper, 4. metallic disc, 5. pressing force, 6. the rotation movement of the disc, 7. the movement of the sample on the disc.*

3. Results and discussions

For the wear testing we used samples with a disc shape with a diameter of 10 mm. The pressing force was made using the weight of the puncher, respectively 126 grams. The length of the distance traveled trough each sample was 7.5 m. We used samples obtained by the electrodepositing on a copper basis. We have measured the mass of the sample before and after the wear testing. The results are presented in table 3 and figure 6.

Table 3. *The variation in mass of the samples after the wear testing*

No.	**Sample**	**Δm** (g/m)
1	G25	0.0014
2	G40	0.0011
3	T35	0.00096
4	T67	0.00092
5	Z21	0.00073
6	Z45	0.00069

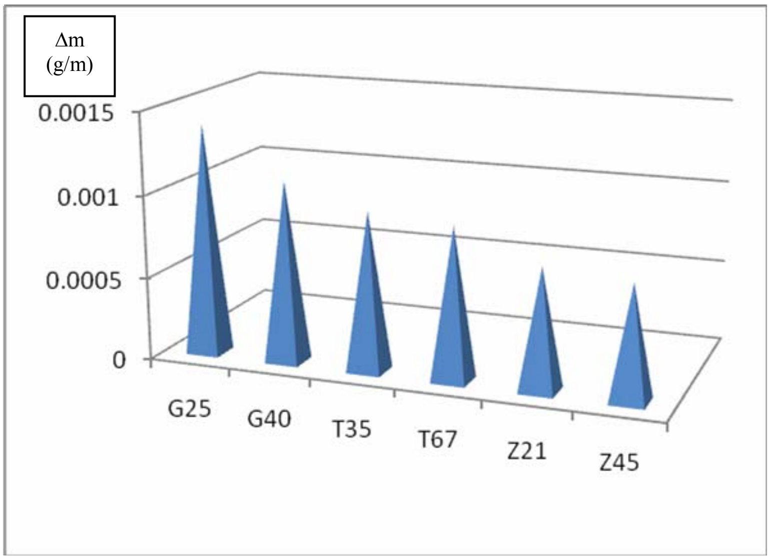


Fig. 6. *The variation of the mass of the samples according to the depositing type*

It can be noticed that the nickel- ZrO_2 layer have the best wear resistance. The wear resistance of each layer depends on the percentage of embedded particles and micro-hardness of the particles.

4. Conclusions

The paper presents some results obtained following an extensive experimental research program on the application of technology for the composites by electrodeposition. Single layers were deposited into a matrix of copper and nickel using copper as a support and TiO_2, ZrO_2, graphite as the dispersed phases. The nickel + ZrO_2 samples (Z45, Z21) have shown the best resistance to wear; more intense wear was noticed in the case of the samples T_{67} and T_{35} ($Ni+TiO_2$) and the maximum wear was in the case of the samples G_{40} and G_{25} (Cu + graphite). Different wear behavior can be explained by the fact that deposited layers have different micro-hardness; matrices are also different (nickel with higher wear resistance than copper).

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