ON THE HARDNESS OF THIN COMPOSITE LAYERS OBTAINED BY ELECTRODEPOSITION

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ABSTRACT*: The composite materials are used in many fields of activity because of their properties. The properties of composite materials are superior to those of ordinary materials precisely because of the way they are formed. Thus, a composite material is composed of at least two components, in which one has the role of matrix, the other being incorporated in the first, in various forms and, which has the role of reinforcement. In this paper is presented the composite material Ni-P/SiC and the results of hardness tests on the layers samples that were obtained by means of electrolytic.*

KEYWORD: samples, electrolytic, hardness, layers

1. INTRODUCTION

Attempts to obtain composite materials have been important concerns of researchers, due to the fact that they needed materials with properties clearly superior to those of ordinary materials and much lighter than them [1,2]. Besides the fact that it was wanted to obtain lighter materials with superior properties, the quality-price-performance ratio is not to be neglected at all.

Due to the performance of these materials, they are used in various fields of activity such as: electronics and electrical engineering, automotive industry, machine building industry, chemical industry, etc. Composite materials are widely used in the aeronautical and aerospace industry, have applications in medicine, are found in sports items and are used in the construction of equipment for recreational sports, etc [1,2].

Important applications of this type of material are also found in the energy industry, for certain components of wind turbines [3, 4].

The mechanical and physical properties of these composite materials are superior to the properties of ordinary materials [5]. These properties thus allow the use of these materials in the fields mentioned above. Also, there are categories of composite materials that have a good applicability in the field of civil constructions, being used to strengthen the resistance elements or to consolidate the existing ones [6,7].

2. EXPERIMENTAL PART

From the multitude of composite materials, those that give a special appearance to the surfaces and provide protection against corrosion have an important applicability.

These types of composites are obtained electrolytic. This category includes Cr-Ni-Co, Fe-Cu-Zn deposits and also Ni-P deposits which enjoy remarkable properties.

Combining the special characteristics of the two components of this composite material, the uniformly deposited electrolytic layer of Ni-P has a good adhesion and ensures a high resistance against corrosion. By introducing fine particles of silicon carbide (which have a high hardness) into the electrolyte, deposits are obtained which confer a high resistance to wear and abrasion.

The tests were performed in order to perform the tests, it was done electrolytic due to

the special characteristics of the layers developed in this way.

Electrolytic processing is a relatively simple process, and the layers thus obtained can be controlled in terms of composition, appearance and mechanical properties.

This is a process that takes place at low temperature, the electrolysis cells are relatively simple to perform, with a relatively long lifespan and a relatively low cost.

The tests were performed on electrolytic deposits, in electrolysis cells, with electrolytic copper substrates, with a thickness of 3 mm [8].

For samples where Ni-P/SiC composites will be obtained, at the end of the electrolysis process, the nickel substrates will be placed in demineralized water and subjected to ultrasound for 3 minutes in order to remove the silicon carbide powder that has not set on the substrate.

These samples were numbered PxSy, where X and Y represent the g/l phosphorus content, respectively the g/l content of silicon carbide (SiC) particles in the electrolysis bath.

The samples were named P20S80, where P20 represents the phosphoric acid content of the electrolysis bath, S80 represents the content of silicon carbide particles, and 60 μm, represents the thickness of the layers. To make the deposits it is necessary to maintain the pH at a constant value of 2. Its value was modified by the introduction of hydrochloric acid, before the introduction of silicon carbide particles, the pH being measured using a pH meter.

The suspensions necessary to make the composites were obtained by introducing the desired amount of particles into a beaker and the electrolyte shown above was added thereto and the suspension thus obtained was stirred for 30 minutes to obtain a homogeneous suspension. The suspension thus obtained was brought to a temperature of 80°C, the pH was checked and adjusted, if necessary, by introducing an appropriate volume of hydrochloric acid and then the suspension introduced into the processing cell. After making a deposition, the resulting suspension was filtered with filters that allow the retention of particles larger than or equal to 1,0 μm, or by centrifugation for smaller particles. The silicon carbide had a purity of 99,9%, the particles having a size of (600 nm) and a specific surface area of 10,4 m^2 / g with a hexagonal structure.

In the experimental part, Vikers microdurity tests were performed. After the end of the electrodeposition process, the thicknesses of the layers were measured, thus observing a difference between the deposited thickness and the real one, obtained experimentally.

For example, in sample P20S80-5μm, for the proposed thickness of 5 μm, the actual value of 4,93 μm was obtained, in sample P20S80-30μm the actual value of 27,66 μm was obtained and for sample P20S80-60μm the value of 58,58 μm.

It is observed that for these 3 deposits the real thicknesses were smaller than the imposed ones. Only for the sample of P20S80-10 μm a measured value higher than the imposed one was obtained, respectively 10,23 μm.

Variable loads of 25g, 50g, 100g, 1kg and 2kg were used in the tests to determine the hardness of the layers.

The following are the results of the hardnesses for the P20S80 sample to which the 1kg load was applied and it was followed how this load influenced both the hardness and the penetration depth.

The paper [9] shows that this hardness is influenced by both the thickness of the layer and the applied load. It is also noted that for the determinations performed with the load of 1 kg and the load of 2 kg, the measured hardness increases with the layer thickness and the measured hardness is not the intrinsic hardness of the layer, but is the hardness of a composite material consisting of a substrate and a deposit. The measurement of the hardness of metallic

materials is performed with the help of the Vickers hardness tester [10].

Regarding the hardness of the samples obtained, this was determined by measuring the diagonals of the fingerprint left by the penetrator of the Vickers hardness tester.

In the following graphs, the variation of layer hardness - penetration depth is highlighted, for the P20S80 sample, at thicknesses of 5 µm, 10 µm, 30 µm and 60 µm.

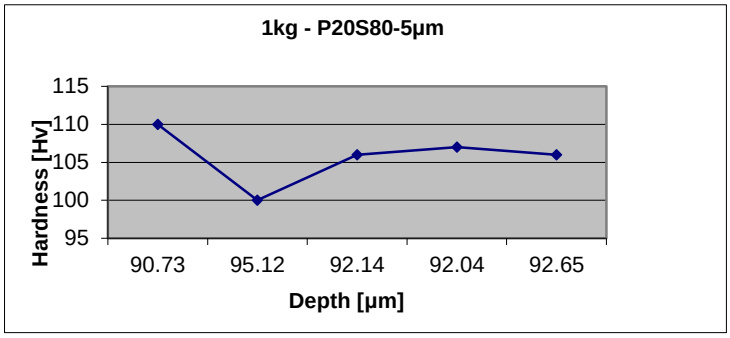

Fig.1 Variation of P20S80-5µm deposition hardness at 1kg load, depending on penetration depth

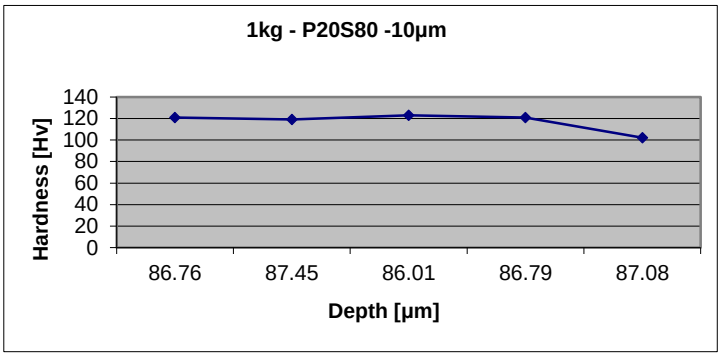

Fig.2 Variation of P20S80-10µm deposition hardness at 1kg load, depending on penetration depth

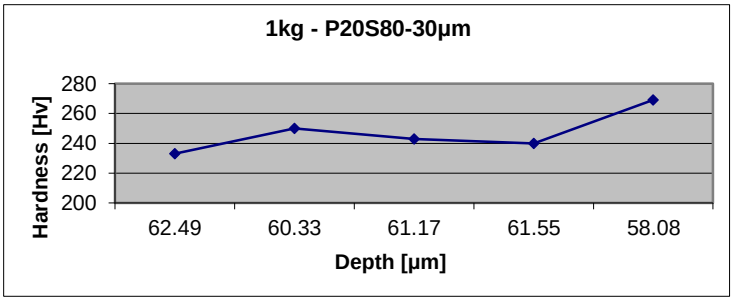

Fig.3 Variation of P20S80-30µm deposition hardness at 1kg load, depending on penetration depth

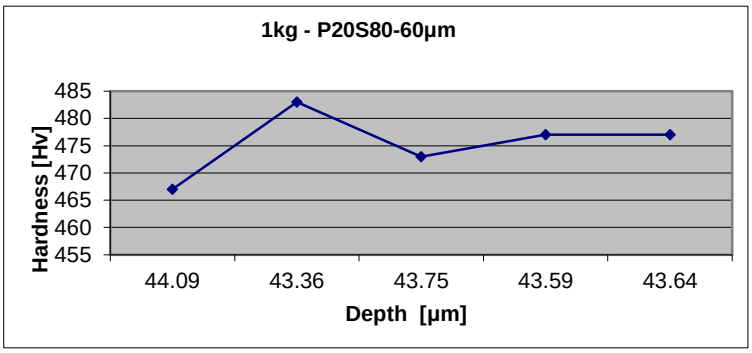

Fig.4 Variation of P20S80-60µm deposition hardness at 1kg load, depending on penetration depth

Studying the graphs above, it is observed that, for the P20S80-5µm sample, a maximum hardness value of 110 HV is obtained, at a penetration depth of 90,73 µm and the minimum hardness value, of 100 HV, is obtained at a penetration depth of 95,12 µm.

In the case of sample P20S80-10µm, the maximum value of hardness is 121 HV, at a penetration depth of 86,76 µm, the minimum value of hardness being 102 HV, at a penetration depth of 87,08 µm. For the P20S80-30 sample, a maximum hardness value of 269 HV is obtained, at a penetration depth of 58,08 µm and the minimum hardness value, of 233 HV, is obtained at a penetration depth of 62,49 µm. At the P20S80-60µm test, a maximum hardness value of 483 HV is obtained, at a penetration depth of 43,36 µm and the minimum hardness value, of 467 HV, is obtained at a penetration depth of 44,09 µm.

The determined results show us that the maximum hardness is obtained at the lowest penetration depth of the deposited layer and the minimum hardness value is obtained at the highest penetration depth.

CONCLUSIONS

Technical progress has led to the emergence of composite materials with superior mechanical properties, which correspond to high technological requirements. These composite materials are used in many fields of activity where they have various applications. One such material is the Ni-P/SiC composite, which was studied in the present paper, which was determined the hardness of the layer applied on the surface of the base material.

After performing the hardness tests, it was observed that this varies depending on the load applied on the respective samples. In this sense, when applying the load of 1 kg, for all samples the hardness has maximum value, at a minimum penetration depth.

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