DEPENDENCE BETWEEN THE HARDNESS OF A COMPOSITE MATERIAL AND THE MODE OF THE FORCE APPLICATION

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ABSTRACT: Composite materials are made up of several components called constituents. It can contains at least two components, one of which has the role of matrix, the other, embedded in the first, having different shapes and sizes, has the role of reinforcement, with well-defined separation areas. Combining these components give rise to a new material whose properties and behavior are superior then the properties of the materials taken separately.

KEY WORDS: composites materials, hardness, load.

1. INTRODUCTION

A composite material is an assembly consisting of at least two materials of different nature, which, by combining them, give rise to a new material whose properties are superior to the properties of the materials taken separately.

Composites materials have been around since the earliest times. The first known natural composite material is wood that is made of long cellulose fibers, linked together by a substance called lignin. Cellulose can also be found in other materials such as cotton or linen. Binding capacity or binding power of lignin makes a piece of wood much stronger than a bundle of cotton yars.

Besides wood, the most primitive artificial composite materials used by humans are the bricks that come from a combination of straw and mud. This combination makes the brick have high compression resistance and high stretch resistance.

If you bend a piece of dry mud, it will break easily, but if it is compressed or crushed it resists.

When trying to stretch a bunch of straw it doesn't break, but will crush easily.

When the mud and straw are combined into one block, the properties of the two materials are combined and a brick is obtained that is resistant to crushing, breaking or bending.

From a technical point of view, the brick thus obtained has a compression resistance and a good tensile strength.

The ancient process of obtaining bricks can be seen on the paintings of the Egyptian tomb in the Metropolitan Museum of Art.

The composite materials have superior mechanical properties that recommend them for the use of products from the top fields (naval transport, aeronautics, mining industry, wind turbines road transport, chemical industry, electronics, telecommunications, medicine, etc) [1,2,3].

Quality is a priority problem in choosing technologies for obtaining parts from composite material.

In order to ensure high quality requirements, both destructive and non-destructive control methods can be applied, as well as techniques for evaluating and improving the quality of the products, for identifying causes that cause quality defects or for establishing actions or measures that will reduce the deviations or quality defects.

Modern tools of quality management have proven techniques applicable in many fields of activity.

Also, the classic tools of quality management, applied in different fields [4, 5], can also be successfully applied in the evaluation and improvement of the quality of composite materials and parts made of composite materials.

As mentioned, composite materials are made up of several components called constituents.

Therefore a composite contains at least two components, one of which has the role of matrix, the other, embedded in the first, having different shapes and sizes, has the role of reinforcement, with well-defined separation areas.

The matrix is the element that has the role to bind and maintain the fibers, distributes the forces (resistance to compression or bending), provides chemical and thermal characteristics and transfers the mechanical stresses.

The matrices can be [6]:

A. Organics:

a) Thermosetting:

- Polyesters
- Phenolic
- Epoxy

Thermosetting matrices are the most commonly used for the manufacture of composite material parts.

b) Elastomers

c) Thermoplastics:

- Polyamides
- Polycarbonate
- Saturated polyester

B) Minerals:

a) Metallics

b) Ceramics

The reinforcements used for a composite material are [6,7]:

A. Organics

a) Polyesters

b) Aramids

B. Inorganics:

a) Minerals:

1. Ceramics:

-glass

-carbon

-boron

2. Metal

b)Vegetable:

1. Wood
2. Cotton
3. Paper

2. TECHNICAL REQUIREMENTS

In this paper presents the results of hardness tests performed on electrodepositions of composite material of the PxSy type, where the index x represents the concentration of phosphorous acid in the electrolyte and the index y is the concentration of silicon carbide particles.

The mode to obtain the fingerprint plays an important role in determining the hardness [8]. Thus, the fingerprint can be obtained in two ways [9]:

a) perpendicular to the section (thickness) of the layer; In this case, between the size of the diagonal of the fingerprint and the thickness of the layer, the relation is established:

$$d \leq 0.7 \cdot hs, \quad (1)$$

where d is the size of the diagonal, and hs is the thickness of the layer

b) perpendicular to the surface of the layer, where the relations are valid:

$$h = \frac{d}{2} \text{ tg } \alpha \quad (2)$$

$$h = \frac{d}{2} 0{,}374 = 0{,}187d; \quad (3)$$

$$h_s \geq \frac{0{,}187}{0{,}85} \cdot d_a \quad (4)$$

$$h_{admis} \leq 0{,}85 \cdot h_s, \quad (5)$$

h_s is the thickness of the layer.

$$h_s \geq \frac{h_a}{0{,}85} \quad (6)$$

$$d \leq \frac{0{,}85 h_s}{0{,}187}; \quad (7)$$

$$d \leq 4{,}55 \cdot h_s. ; \quad (8)$$

$d = d_a$ is diagonal to the fingerprint;

$$h_s \geq 0{,}22 \cdot d_a \quad (9)$$

The electrodeposited composite layers were obtained in the electrolysis cell shown in figure 1 [10]. For these samples, Vickers micro-hardness was measured, applying the load of 15g.

Hardness tests were performed on four samples of nickel-phosphorus and SiC electrodepositions.

NiP alloy had different contents and were obtained in an electrolyte with different concentrations of phosphorous acid (0 g/l, 5g/l, 10 g/l, 20 g/ l) and constant content of hard silicon carbide particles (40 g/l).

The method of obtaining the composite electrodeposits of Ni-P/SiC type were presented in the paper [10].

The micro-hardnesses resulting from the tests were obtained by applying the force of 15g in the two modes presented: perpendicular to the surface of the layer and perpendicular to the section of the layer.

The dependence between the phosphorous acid content, hardness and the load applied perpendicular to the surface and perpendicular to the section is shown in figure 2.

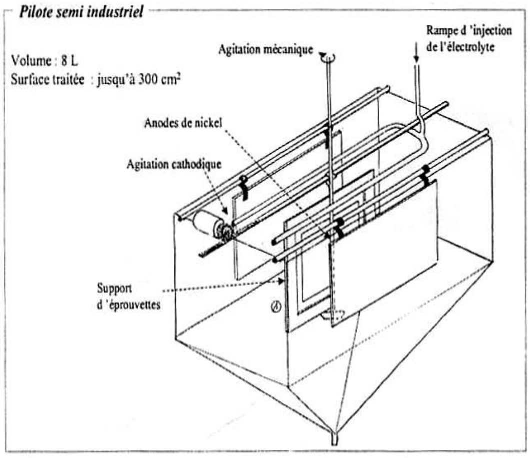

Figure 1. Electrolysis cell [10]

The curves in figure 2 show that the three hardnesses (hardness of the substrate, hardness obtained on the surface of the electrodeposition composites and hardness on the section of the layer) have the same allure.

The important observation is that the hardness obtained by applying the force of 15 g perpendicular to the section of the layer is greater than the hardness obtained perpendicular to the surface of the layer (electrodeposition).

Another observation is that the 15 g applied load does not penetrate the NiP/SiC material, so the hardness obtained is the hardness intrinsic to the NiP/ SiC composite material.

3. CONCLUSION

Composite materials have appeared since ancient times and, due to their remarkable properties, have come to be used in many fields (aeronautics, electronics, medicine, transport, etc.).

The hardness of the NiP/SiC type electrolytic deposition depends on several factors: working conditions, working parameters, electrolyte composition, applied load, etc.

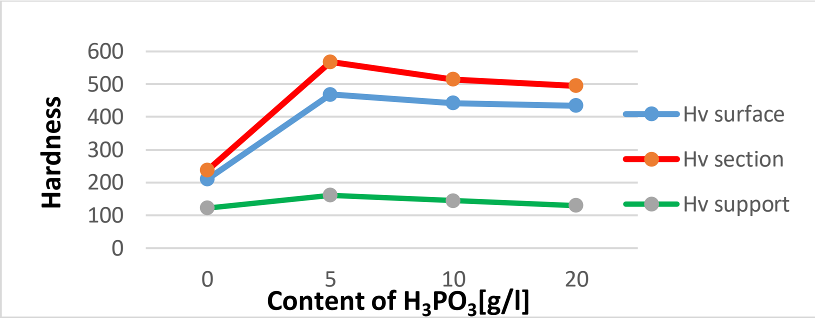

Figure 2. Variation of hardness on the surface, section and substrate of the deposit according to the H_3PO_3 content

Determination of Vickers hardness for deposits with variable phosphorous acid content and constant content of hard SiC particles, at a constant load of 15 g, showed that the hardness depends on where the force is applied. Thus, it was found that the hardness obtained by applying the force perpendicular to the section of the layer is higher than the hardness obtained perpendicular to the surface of the layer.

It has also been found that the small applied loads do not penetrate the electrodeposited layer, so the hardness obtained is the intrinsic hardness of the NiP / SiC composite material.

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