

BRIEF ON THE COMPOSITE ELECTRODEPOSITION

Assoc. Dr. Eng. Minodora Maria PASĂRE, „Constantin Brâncuși” University, Tg-Jiu
Assistant dr. eng. Cătălina Ianăși, „Constantin Brâncuși” University, Tg-Jiu

***Abstract:** Development of materials deposition was determined by scientific and technical material requiring special properties that cannot be produced by other processes, or special surface properties of common materials. They were introduced in almost all sectors: aeronautics, mechanical engineering, metallurgy, food industry etc.*

Keywords: composites, electrodeposition, mathematical models

1. Introduction

In research done in time, submissions were made in layers with variable thickness, were deposited coatings on parts with complex geometric configuration of the basic material properties that give us able to meet user requirements (corrosion protection, tribological properties, optical, thermal, decorations, etc.). To obtain a deposit which is required to have special properties, primarily meet the technical imperatives of protection against corrosion, resistance to friction, wear, high temperature, high hardness, etc., to satisfy the conditions of service and reliability.

The composite material is a set of two or more macroscopically homogeneous materials with different structure and properties, combining the qualities of individual components, forming a heterogeneous material with improved overall performance. Therefore, a composite made up of at least two components, one-function matrix, the other box in first, with different shapes and sizes, serves as reinforcement, with clear-cut separation surfaces [1].

Composite materials are extremely varied, depending on the nature of the matrix, the nature, form and size of reinforcement. Depending on the nature of matrix composite materials can be: metal-matrix composites, plastic matrix composites, ceramic matrix composites, carbon composites.

Depending on the nature of reinforcement, composites can be reinforced with: carbon fiber, glass, carbides, oxides, nitrides, metals, etc.. in different shapes and sizes. Composite coatings can be divided into five types:

- coatings (layers) to wear and abrasion resistant;
- coatings (layers) with self-lubricating properties;
- coatings (layers) of dispersed high toughness;
- coatings (layers) for finishing the surface to improve resistance to abrasion and oxidation;
- coatings (layers) active.

2. Layers of different types of composite matrix

2.1 Layers of nickel matrix composite

In nickel, the matrix may be incorporated into any kind of particle, the particle suspension that the electrodeposition of nickel electrolyte. Codeposition of SiC in the matrix of nickel induces a high hardness deposited layers. Carbides of tungsten, chromium, titanium and nickel matrix are studied electrocatalytic effects, in order to replace precious metals. Electrodeposition of nickel sulphides in the matrix was developed as an alternative to lubrication or catalytic activity electrodes produce hydrogen for various processes in the evolution of electrocatalysis.

Diamond particles introduced into the nickel matrix leading to fine grinding surfaces needed in dentistry.

A true revolution in obtaining new metal matrix composites is the introduction of liquids by codeposition microcapsules containing liquid and enjoy certain properties:

- manufacture of self-lubricating surface properties by codeposition oil microcapsules;
- increased resistance to corrosion by introducing corrosion inhibitors;
- production of metal foam type structures, obtained after heat treatment of liquid metal composites.

This is a process in which micro-fine droplets of liquid are surrounded by a coating to give small capsules. These microcapsules consist of a liquid interior surrounded by a solid wall, called a shell, shell or membrane. This coating is often a natural or synthetic polymer. Capsules with sizes between 1 and 1000 nm are called microcapsules. Processes known for producing microcapsules with liquid inside is divided into three categories:

- interfacial polymerization;
- in-situ polymerization.

2.2 Layers of copper matrix composite

The most studied copper matrix composite layer is obtained by codeposition of aluminum oxide. Best corrosion resistance is a copper matrix composite layer and zirconium oxide. Obtaining copper matrix composite layers with dispersed particles of sulphide with resistance to wear and use against friction. As codeposition sulfides are sulfides of molybdenum and tungsten. The electrodeposition of carbon in copper matrix, composite layers obtained gives special lubricating properties, being used as solid lubricant and is the oldest composite coating obtained by electrodeposition. Compared with molybdenum disulphide, graphite is more effective in copper matrix, to reduce friction wear. Codeposition red phosphorus particles in the matrix of copper from acid copper plating bath, is a method of obtaining copper phosphorized which is preferred as anode material in shiny copper plating. The inclusion of chromium carbide in nickel-cobalt alloy matrix, gives a high resistance to wear elastic deformations.

Tribological studies of dry friction at temperatures between 20^o C and 750^o C, demonstrated the superiority of the composite obtained by electrochemical codeposition. Wear resistance and temperature electrodeposition of silver can be improved by codeposition of aluminum oxide particles. Matrix composite layers of gold dispersed particles of aluminum oxide are also reported to improve their wear resistance. Nickel-phosphorous alloys obtained by chemical reduction is very good matrix composites in obtaining thin layers with aluminum oxide as dispersed phase. Also in these alloys can be codeposited fine particles of zirconium metal and niobium.

2.3 Polymer composite coatings

Ultrafine polymer films can be deposited on polymers by electrochemical polymerization method. Such films adhere well to the substrate, are chemically stable to the action of liquid electrolytes and inert electrodes can confer catalytic activity. The catalytic activity can be increased by incorporating metals in the form of clusters. Electrochemical process can take place at the interface of polymer / electrolyte and the electrons are transported through the polymer film.

Polymer is deposited on a metal substrate, usually platinum [6,7,8]. This process takes place in two stages:

1. electron transfer from / to the electroactive species in solution (from) the surface of the polymer.

2. electron transport through polymer film

Polymer matrix acts as a membrane, allowing the electroactive species and electrolyte to pass the underlying metal surface / polymer, a region in which the load reaction transfer.

3. Mathematical models for the electrolytic codeposition

Mathematical models have been proposed from experimental observations on the codeposition of a composite system.

3.1 The proposed Saifullin model calculates the percentage of the composite layer as follows [3]:

$$\text{Wt}\% = m / m \times 100\% \quad (1)$$

Where:

Wt% = weight percentage of particles incorporated into particles; m = the mass of particles in a composite layer cm^3 ; m = the mass of a composite layer cm^3 .

Bazzard and Boden's model proposed the formula [4]:

$$\text{wt}\% = \frac{\frac{4}{3} \pi r_p^3 \rho_p}{\frac{4}{3} \pi r_p^3 \rho_p + 4 \pi r_p^2 e_m i t} \quad (2)$$

where:

e_m = the electrochemical equivalent of metal; r_p = the particle radius; t = the time of submission;

i = current density

3.2 Guglielmi's model

It has the following formula [2]:

$$\frac{\alpha}{\alpha - 1} = E (B-A) \eta \quad (3)$$

where:

α = volume fraction of particles in the deposit; n = valency of metal; F = Faraday's constant; ρ = density of metal; η = surge; B, A, Vo = constant; I_o = exchange current density; k = constant, which depends on the interaction between particles and cathode; Cv = volume fraction of particles in suspension.

3.3 The model proposed by Celis, Roos and Buelens

For mathematical treatment of the dispersed codeposited particles, are assumed to be stationary conditions achieved, so that the concentration, temperature or pressure do not vary during the process and the cathode surface is uniformly accessible to the electrolyte suspension. Quantitative description of the incorporation of a particle in a growing metal matrix can be assessed by a statistical relationship, the coefficient P is the probability that a

particle is codeposited, and N_p , the number of particles passing through the diffuse double layer the electrode in unit time and per unit area. Increasing weight composite layer, per unit time and surface area, ΔW_p , resulting from the incorporation of particles, can be written as follows [5]:

$$P = N_p W_p \Delta W_p \quad (4)$$

where: W_p = weight of a particle; N_p = number of particles passing through the diffuse double layer. Spherical particles are considered, the weight of a particle is:

$$W_p = \frac{4\pi r^3}{3} \rho_p \quad (5)$$

1. Electrolytic deposition of composite coatings of nickel-phosphorus matrix and hard SiC particles

Development of composite materials require special facilities that are able to ensure optimal conditions for development. To obtain layers which have remarkable properties, electrolytic cells where these deposits are obtained has to ensure optimal working parameters. The figure 1 presents a cell equipped with special equipment to maintain the electrolyte temperature, electrolyte agitation and to provide for moving parts [9].

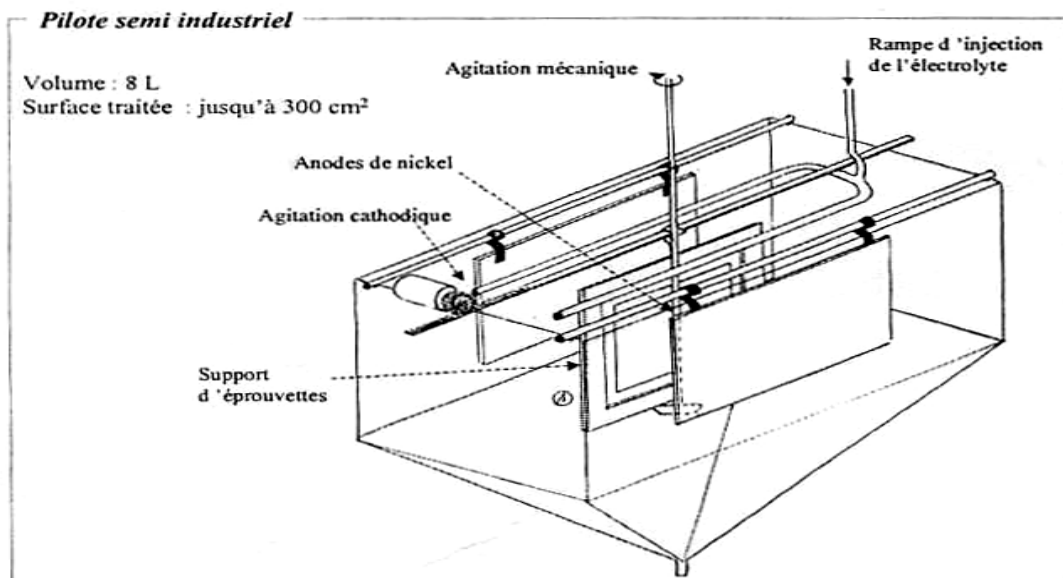


Fig. 1 The electrodeposition cell for composite layers

This cell type is a bustle of elecrolitului suction at the bottom of the tank with a pump peristatică. Temperature is ensured by an oil bath which is in a cell with double walls. Electrolyte return is calibrated through distributors willing electrolyte surface. Replacing the electrolyte is in part controlled by the pump speed. Electrolytic process development work in complying with conditions such as electrolyte composition, pH, temperature and agitation. Important experimental results of hardness, wear, corrosion, etc. are made to change the content of phosphoric acid in the electrolyte (Fig. 2).

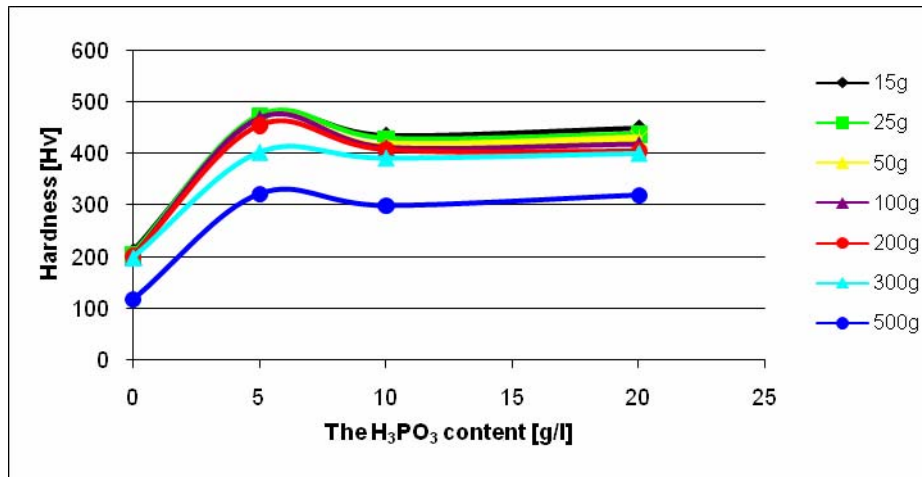


Fig. 2 Variation of hardness deposits depending on the applied load and phosphorous acid in the electrolyte content

Variation of phosphorous acid content determines the variation of phosphorus incorporation in the layer (Fig. 3).

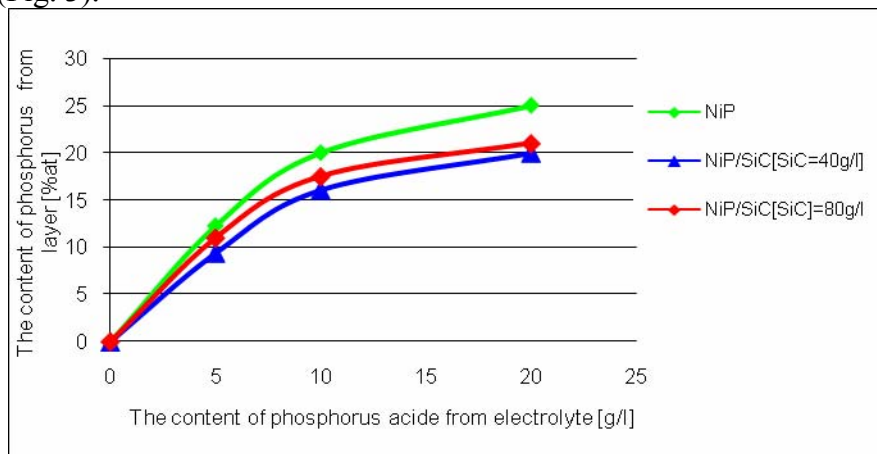


Fig. 3 The phosphorus content variation depending on phosphoric acid from electrolyte

The amount of phosphorus incorporated into the layer increases with increasing content of phosphoric acid in the electrolyte. The content of phosphorus incorporated into the layer evolves as both composites and solid solutions without particles. In the first part of the curve, where the content of phosphoric acid in the electrolyte is low and where are microcrystalite alloys, particulate phosphorus content changes little. The increase included phosphorus layer is observed that incorporation of phosphorus is higher at increasing the amount of silicon carbide particles.

Also the number of particles deposited per unit area depends on the electrolyte content of phosphorous acid and phosphorus content of the default layer. Increasing the content of hard particles increases the quantity of particles deposited per unit surface layer and the amount of hard particles is not constant codeposited on the whole composition domain. This phenomenon is especially striking with hard particles as the electrolyte concentration is higher [9]. For deposits with high content of hard particles begin to saturate the amount surfaces low content of phosphoric acid. For deposits with a lower concentration of hard particles that saturate of particles quantitie per unit mass is lower, but still noticeable.

5. Conclusions

Electrodeposited metal matrix layers are a solution to increase performance and reliability of parts.

Metal matrix composite deposits and phases built tough with the role of reinforcement are part of advanced materials currently being studied as layers tribological properties. Incorporation of hard particles in metal matrix composite obtained electrodeposited is a complex process that requires additional parameters to the metal deposits and their strict observance (electrolyte, agitation, temperature, pH). Alloy layers and Nip Nip matrix composites were made by hand in the electrolyte.

There are studies on the influence of working conditions (temperature, amount of chemical compounds in the electrolyte, etc.) layer on the characteristics. It was found that increasing the content of phosphoric acid in the electrolyte between 5% and 20%, we get an increasing amount of phosphorus incorporated into the phosphor layer and deposited layer that is evolving as both composites and solid solutions without particles.

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