# APPROACH REGARDING COMPOSITE ELECTRODEPOSITIONS

**Pasăre Minodora-Maria, Assoc. Prof.** *"Constantin Brâncuşi" University of Târgu Jiu, ROMANIA*

**Abstract:** This paper presents a brief overview of composite materials, punctually of Ni-P composite electrodepositions. The existence of composite materials and their use has been known for a very long time. In the specialized literature there are several models of co-deposition of composite material states. With the development of manufacturing techniques were obtained composite materials with remarkable properties (resistant to wear, shock, corrosion, etc.), which led to their use in a wide range of fields (aerospace, energy, civil engineering, medicine, sports etc).

**Key words**: composite materials, electrodeposited layers, Ni-P electrolytic deposits, electrodeposition parameters

## 1. INTRODUCTION

Composite materials are considered new, last generation materials.
A composite material consists of two or more macroscopically homogeneous materials, which have different structure and properties and which, following the combination of the individual qualities of the constituents, form a heterogeneous material with improved overall performance. Therefore, a composite consists of at least two parts, in which one with a matrix function, the other, embedded in the first, with different shapes and sizes, has the role of reinforcement, with well-defined separation surfaces.

Due to the variety of outstanding properties they possess (high tensile strength, high resistance to mechanical shocks, fatigue strength, corrosion resistance, high temperature resistance, high vibration damping capacity, high durability in operation, high chemical stability etc.), have a great applicability in many sectors of activity (aerospace industry, energy industry, wind industry, automotive industry, mechanical industry, electronics, medicine, road transport, railway, maritime, civil construction, sports - skiing, rockets tennis, surfboards, sailing boards, etc.) [1-4], [5-7].

An important aspect in the successful use of these materials is the application of thin layer deposits of composite materials. These composite coatings, like all composite materials, must have special properties that meet the technical imperatives: protection against corrosion, abrasion resistance, wear, high temperatures, hardness, etc., while satisfying the conditions of operation and maintenance.
The choice of a deposit must satisfy a combination of several factors:
a) The nature of the elements that form the composite layer (the nature of the constituents that form the composite);
b) Characteristics of the deposit:
- mechanical characteristics: adhesion, resistance to abrasion, abrasion, creep, etc.
- chemical characteristics: high temperature resistance, corrosion resistance
- physical characteristics (thickness, porosity, texture, etc.)
c) Economic considerations:
- composite materials are more expensive than traditional materials because the installations in which they are obtained have a high cost price
- the life of composite materials is longer because they are resistant to mechanical factors (wear), chemical factors (corrosion), etc.
d) Aspect
e) The quality of the deposited layers. Quality evaluation and improvement can also be achieved by using quality management tools, tools that have proven their applicability in many areas of activity [8, 9].

## 2. ELECTROLYTIC DEPOSITS BASED ON NI-P

Nickel was first electrodeposited in 1837, when is used nickel chloride electrolysis to obtain a nickel metal crust on a platinum electrode.

In 1844 Wurtz obtained a nickel deposit from an aqueous solution of nickel hypophosphite, heated to 100°C.

The first nickel-phosphorus deposits were chemically engineered. With the development of electrolytes by Brener [10] it was possible to obtain NiP deposits electrolytically.

NiP layers are deposited electrolytically uniformly on parts with simple configuration as well as those with complex configuration, have a high resistance to wear and corrosion, high hardness, etc., properties characteristic of composite materials.

The principle of electrochemical deposits is based on the electrolysis process of aqueous solutions of simple or complex salts containing the metal ion to be deposited.

The cathode is represented by the part to be coated, and the anode of the direct current source can be an inert unassailable metal (for electrolysis with insoluble anode) or the coating metal that dissolves in solution in the form of ions (for electrolysis with soluble anode), moves and discharges (deposits) at the cathode, forming the protective metal layer. The electrolysis bath of the cell or electrolyte comprises a mixture of a metal compound which decomposes and deposits in a well-determined concentration, buffers for maintaining a constant acidity (pH) of the solution, inorganic substances for increasing the electrical conductivity, and special additives to improve the porosity, adhesion, gloss or structure of the protective layer.

Schematically the electrolytic deposition is shown in figure 1, from below:

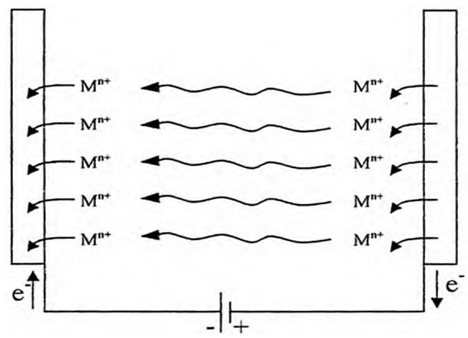


Fig.1. Schematic diagram of electrolytic deposition

The duration of the deposition process depends on the thickness of the layer imposed by the technical conditions and is calculated with the relation:

$$\tau = \frac{0,6\delta.\rho}{K.J.\eta} \text{ [min]}, \qquad (1)$$

$\delta$ - the thickness of the metal layer, in µm,

$\rho$ - the density of the deposited metal, in g/ $cm^3$,

K -the electrochemical equivalent of the metal (the amount of metal deposited on the amount of electricity per unit time), in g /Ah,

J - the density of the current, in $A/dm^2$,

$\eta$ - the yield of the current,%.

The creation of composite layers involves the contacting of different elements that form the particle - electrolyte - electrode system and within which they interact.

As the ratio between the surface of the electrode (metal) and the volume of the solution is small, at the contact of the two components (electrode-electrolyte), there will be no changes in the composition of the electrolyte. As the electrolytic bath is a concentrated solution, its composition will not change due to the interaction of the electrolyte with the metal. In addition, the electrolytic baths being concentrated solutions, their composition is little influenced by the interaction with the electrode surface.

*The process of incorporating phosphorus*

Phosphorus incorporation is a complex process and in the literature [11-14] several mechanisms are proposed to explain this. All research has shown that there is a close link between the amount of phosphorus that is incorporated into the layer and the concentration of phosphoric acid in the electrolyte. Thus, the higher the $H_3PO_3$ content in the electrolyte, the more phosphorus is incorporated in the electrodeposition (fig. 2) [15].

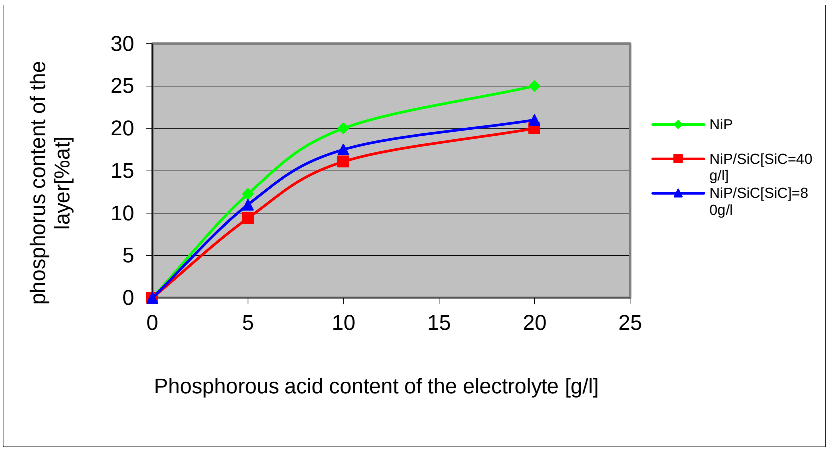


Fig. 2. Variation of phosphorus content as a function of phosphoric acid in the electrolyte

*The influence of the pH of the solution*

This parameter is considered the most important [10], because its variation can increase the speed of the electrodeposition process; has an influence on the adhesion of the layer deposited on the transition metals; influences the phosphorus content of NiP deposition.

Some authors [14], [16] note a decrease in phosphorus concentration with increasing electrolyte pH.

The same aspect is specified in the paper [12] and shown in fig. 3. All these authors agree that if the pH is too basic compared to the optimal value, the deposit is blackish. This color corresponds to the formation of nickel hydroxide Ni (OH) 2. If the pH is lower than the optimum value, a decrease in yield is observed.

*Temperature*

This parameter plays an important role in the deposition yield and phosphorus content of the layer. In the literature [10], Narayan [17] also reports a decrease in phosphorus content with increasing temperature.

Pouderoux [14] also observed a decrease in the percentage of phosphorus related to the increase in temperature.

Future research will continue on other types of composite materials which, through their properties, contribute to improving the properties of the used materials [18]. Tests can also be performed on materials with hard particles, following the application of heat treatments to see how the materials behave under their influence.

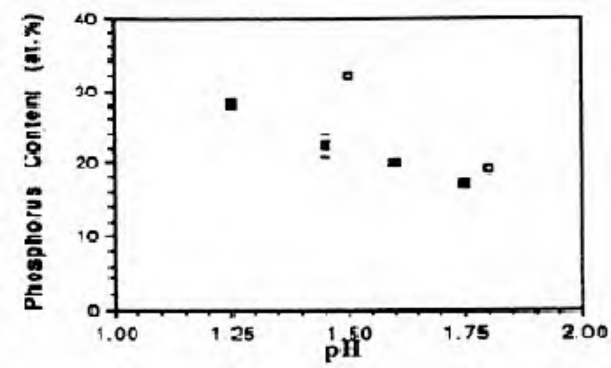


Fig 3. Influence of pH on phosphorus content in the deposit after Harris [12]

## CONCLUSIONS

Composite materials are known and have been used since ancient times.
In the specialized literature is presented their evolution as well as the ways of obtaining them. The electrodeposited layers of Ni-P are part of the category of composite materials and their obtaining is related to the observance of the working conditions. Thus, in the paper is presented the process of incorporating phosphorus in the material, the influence of the pH of the solution and the influence of temperature.

Following the deposition of the NiP material, uniform layers with a homogeneous structure were obtained. These layers have good properties such as hardness, wear resistance, shock resistance, etc.
These remarkable properties have led to their widespread use in various fields such as: aeronautics, electronics, energy, wind industry, medicine, sports, civil engineering, automotive industry.

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