

# INFLUENCE OF THERMAL TREATMENT APPLIED TO COMPOSITE DEPOSITS ON PITTING CORROSION

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**ABSTRACT:** *Corrosion is the phenomenon of degradation of metallic materials under the chemical or electrochemical action of the environment or of substances with which the materials interact. There are several types of corrosion, and significant deposition of NiP/SiC composites is pitting corrosion. The corrosion tests were performed by cyclical voltammetry. The cyclic voltammetry curves for composite deposits from electrolytes without different phosphorus acid concentrations and applied to thermal treatments of 190 ° C and 420 ° C show that they have similar behavior at localized corrosion, but the surface of the cyclic voltammetry curve is higher for thermally treated sample at 420 ° C (POS404). Thermal degassing leads to increased corrosion resistance.*

**KEY WORDS:** corrosion types, protective composite layers, pitting, cyclic voltammetry curves

## 1. Introduction

Corrosion is the phenomenon of material destruction due to chemical or electrochemical reactions on the environment. Chemical destruction reactions occur in all raw materials used in industry, and electrochemical reactions occur only on metals because they only possess free electrons. Synthetic materials are subject to degradation only by chemical attack. A corrosion wire provides an electric current whose intensity expresses the rate at which corrosion propagates. The corrosion cell has two characteristics: electromotive force and internal resistance. The electromotive force of the corrosion cell expresses the thermodynamic contribution, the role of the material and the aggressive agent are taken into account by equilibrium potential. The internal resistance of the corrosion cell is expressed by the kinetic contribution, materialized by the irreversibility of the layer oxidation phenomena and / or aggressive agent reduction and by the contribution of ohmic origin related to the properties of the electrolyte that comes into contact with the interface. Anticorrosive protection is made with the protective coatings which is sometimes the main function of the layer [1]. Most protective layers have complementary functionalities: tribological properties, superficial hardness, thermal protection and corrosion resistance that is an important factor which influences the life of the layer and its functionality.

### 1.1 Classification of corrosion processes

Classification of corrosion processes can be done according to several criteria [2]:

#### A) *By appearance of destruction*

I. *General corrosion*, the entire surface of the metal is affected by corrosion, more or less uniform, and involves the passage of metal ions into the solution in the case of liquid media or the coating with reaction products in the gases at high temperatures.

II. *Localized corrosion*, is characterized by the fact that the attack is limited to specific areas or parts of a structure. Most of the localized corrosion forms are difficult to predict, and once the attack is initiated, propagation takes place at high speed, leading to premature removal of the machine, which is why the localized corrosion is considered dangerous.

- a) *Pitting*, is a localized corrosion where small dots or holes are formed. They usually penetrate from the top of a horizontal surface down in an almost vertical direction. It is a

highly aggressive type of corrosion, often going unnoticed and with very low material losses until the plant is discharged [2].

- b) *Corrosive cavitation*, is a combined action of chemical and chemical attack mechanical abrasion or wear as a consequence of fluid displacement. Virtual, all metal alloys, to a certain degree, are susceptible to corrosive cavitation.

- c) *Corrosion in the crevasses* (also known as the concentration pile) occurs in metals in a metal-metal joint at the edge of a two-metal joint even if they are the same or the corrosion of a point on the surface of a metal covered by another material. It is a synthesis of all localized corrosion. In it we can find galvanic corrosion, intergranular corrosion and point corrosion. [3].

- d) *Galvanic corrosion*, consists in the destruction in corrosive environments of systems consisting of two different metals in direct contact or which are interconnected by an electronic conductor and is frequently encountered at joints by welding, iron and zinc contact (galvanized sheet), copper and brass in the heat exchangers. [4].

- e) *Intergranular corrosion*, occurs along the bonds between granules for some alloys and in certain environments. Intergranular corrosion is a particularly serious problem in the welding of stainless steels, when it is called the destruction of welding[1].

- f) *Selective corrosion*, consists in destroying the alloy by passing a solution into a component and by accumulating on the surface of the other elements (Ex. - Brass in acid medium suffers dezinc in which Zn passes into the solution and on the surface remains Cu.).

-1. Dezinc brass

-2. Graphic corrosion of cast iron

-g) *Corrosion cracking*, occurs due to the simultaneous action of the corrosive environment and the stretching stress. It spreads intercrystalline and transcrystalline in the direction of maximum effort [5].

- 1. Embrittlement

- 2. Corrosive fatigue

### **B) By place of partial reactions**

a) *Homogeneous corrosion*, is the process in which anodes and cathodes cannot be distinguished by experimental way, whether separated from atomic distances, or that the same surface functions alternately as an anode or cathode [2].

b) *Heterogeneous corrosion*, is the process in which certain areas of the metal, which can be distinguished experimentally, function predominantly anodic or cathodic [2].

c) *Corrosion through film*, characterizes corrosion systems in which the metal surface is covered with a film of adherent reaction product. The reaction product acts as a solid electrolyte to transfer electrically charged particles (ions or electrons) [2].

### **C) After the mechanism of the process**

a) *chemical*, there is a direct chemical reaction between the metal and the environment, without the exchange of electrical charges.

b) *electrochemical*, a load transfer occurs at the metal / aggressive environment interface.

## **2. Experimental part**

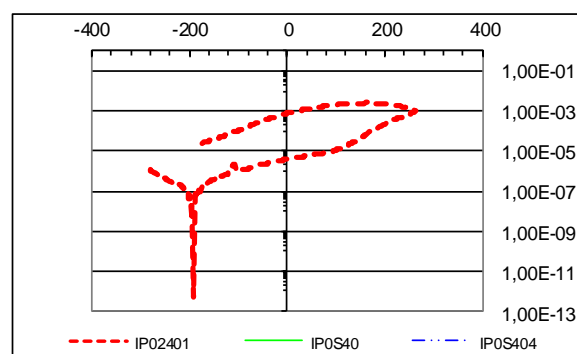
Primary layers of corrosion protection are to some extent meet the requirements for which they have been applied, under the intended working conditions and for an estimated service life. In the case of heat-resistant coatings for which the resistance to aggressive environmental performance has not been prioritized, corrosion resistance is an important factor that influences the life of the coating and its functionality. The corrosion tests were made on Ni-P /

SiC protective layers. In the electrolytic deposition of NiP / SiC composite material, the absorption of hydrogen in the material is important and significantly influences its electrochemical behavior. This also influences the corrosion behavior of the composite, making it more sensitive to pitting corrosion [6].

The corrosion study aimed at influencing phosphorus content in the NiP matrix and thermal dehydrogenation and phosphorus treatment on the corrosion behavior of layers with the same amount of SiC. The corrosion tests were performed by cyclic voltammetry and the corrosion equipment was presented in [6]. Cyclic voltammetry is a very useful modern electrochemical method which allows the obtaining of thermodynamic and kinetic information of the electrochemical systems by means of which:

- the apparent standard potential and the diffusion coefficient in an electroactive space;
- evaluation of the electroactivity domain of different electrode materials;
- assessing the double layer capacitance of an electrode in the presence of an electrolyte solution. Corrosion tests were performed on NiP / SiC (POS40) composite samples without phosphorus, which were subjected to two thermal treatments at 190°C and 420°C, where P<sub>x</sub>S<sub>y</sub> represents the phosphorus acid content of the electrolyte, respectively the content of incorporated silicon carbide particles, and "1" and "4" represents the thermal treatment at the temperature of 190°C and 420°C applied to the deposits.

The two samples have a similar behavior at localized corrosion, but the surface of the cyclic voltammetry curve is higher for the thermally treated sample at 420°C (POS404). Thermal degassing determines the increase in corrosion resistance (Figure 1).



**Figure 1:** Cyclic voltammetry diagrams for composite deposits made from an electrolyte without phosphorous precursor, non-phosphorus matrix, thermally untreated and heat treated at 190°C and 420°C

### 3. Conclusions

In the electrolytic deposition of NiP / SiC composite material, the absorption of hydrogen in the material is important and significantly influences its electrochemical behavior. This also influences the corrosion behavior of the composite, making it more sensitive to pitting corrosion.

The corrosion study aimed at influencing phosphorus content in the NiP matrix and thermal dehydrogenation and phosphorus treatment on the corrosion behavior of layers with the same amount of SiC. The cyclic voltammetry curves for composite deposits from electrolytes without different phosphorus acid concentrations and applied to thermal treatments of 190° C

and 420° C show that they have similar behavior at localized corrosion, but the surface of the cyclic voltammetry curve is higher for thermally treated sample at 420°C (P0S404). Thermal degassing leads to an increased corrosion resistance.

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