# Elaboration and structural characterisation of NiP/talc layers

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The NiP layers witch contain diverse particles have attract considerable attention lately, especially because of their resistance to wear and improved tribological properties. The aim of this paper is to obtain and characterize NiP coatings with talc particles incorporated. Composite NiP deposits of talc particles were made to develop deposits for lubricant tribological applications.

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## 1. Introduction

The NiP layers witch contain diverse particles have attract considerable attention lately, especially because of their resistance to wear and improved tribological properties. The composite coatings can be prepared by different process from which the electrodeposition or autocatalytic (electroless) deposition are the most adaptable. The processes consist of incorporating particles to the metallic matrix from an electrolyte containing particles in suspension [1]. In some applications such as bearing or pipe lining, the Ni–P coatings serve as a wear resistant function layer in the corrosive environment. It has been shown that the synergistic effect under tribocorrosion, such as the interactive chemical–electrochemical – mechanical process of materials in sliding or rolling contacts immersed in a corrosive environment, can be complicated [2].

Therefore, the aim of this paper is to obtain and characterize NiP coatings with talc particles incorporated. Composite NiP deposits of talc particles were made to develop deposits lubricant tribological applications. The process consists of inserting micrometer particles of talc in the form of particulate matter in a chemical purity nickel bath. Talc is a natural magnesium silicate with the formula $Mg_3Si_4O_{10}$ easy hydroxy $(OH)_2$, formed by superposition of nanometer layers (0.9 nm) [3]. Weak interactions between these layers allow their fall in relation to each other, under the effect of shear stress. On a macroscopic scale, this behavior makes talc has a very low coefficient of friction and lubricating properties when particles are present at the interface between two bodies in motion. The advantage compared to materials such as talc Teflon (PTFE), graphite or molybdenum disulphide ($MoS_2$) is high thermal stability, being stable in air up to 900°C, which allows us to consider the use of such deposits for applications high temperature mechanical [4].

## 2. Materials and experimental methods

Evidence for deposition of composite surfaces were polished, cleaned and degreased, being kept in acetone for 1 minute. Next, they were rinsed in distilled water at room temperature. To achieve a particularly cleaning these surfaces, the samples were immersed in an etching solution of hydrochloric acid (concentration 50 g/l), heated to 50°C, after which they were rinsed in distilled water at room temperature and then dried. The deposits on 35NiCrMo16 steel samples were carried out in baths industrial, low-phosphorus. Spectral analysis of selected steel as the substrate (35NiCrMo16) revealed the following chemical composition: 0.33% C, 0.30% Si, 0.40% Mn, 1.75% Cr, 0.45% Mo, 4.00 % Ni, Fe rest. The samples were heat treated before or after filing the composite layer. The type substrate microstructure is therefore ferito-perlitic. The talc is a hydrophobic substance; therefore putting it in solution is quite difficult as talc particles tend to foam and crowding in contact with the liquid. To avoid such problems, talc particles were pretreated with thus improving their wetting ability, while decreasing their speed rearrangement. To achieve composite deposit, the amount of talc particles is fed into the nickel bath agitated by a mechanical shaker to 1000 rev / min, and then continues with a stirring speed of 500 $min^{-1}$ for 30 minutes. The stirred suspension is heated to 88° C, checking the pH from time to time. Talc used contains no chlorine or other minerals, is so very pure composition very close to that standard.

## 3. Results and discussions

### 3.1. Composition of deposited layers

The phosphorus content determined by X-ray spectrometry with energy dispersion (EDX) ranged between 4 ... 6% by mass; the values measured are presented in Table 1. The table shows that as the concentration increases talc composition electrolytic bath, increases the concentration of phosphorus in the composite layer deposited.

*Table 1. The phosphorus content of the deposited layers with different concentrations of talc*

| Type of deposit | P % mass | P% atomic |
|---|---|---|
| NiP 0 g/l talc | 3,96 | 5,62 |
| NiP 40 g/l talc | 3,89 | 6,03 |
| NiP 120g/l talc | 5,65 | 8,55 |

Figs. 1-3 present results spectrometric analysis (EDX method) to determine the initial chemical composition of the layers of composite NiP no added talc (Fig. 1), 40 g / l talc (Fig. 2) and 120 g / l talc Fig. 3).

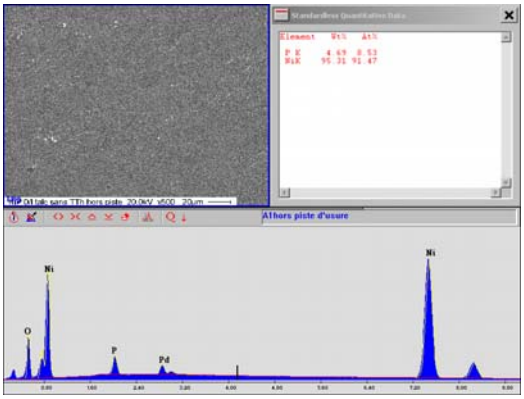

*Fig. 1. EDX diagram showing the chemical composition of the composite layer deposited (NiP without talc)*

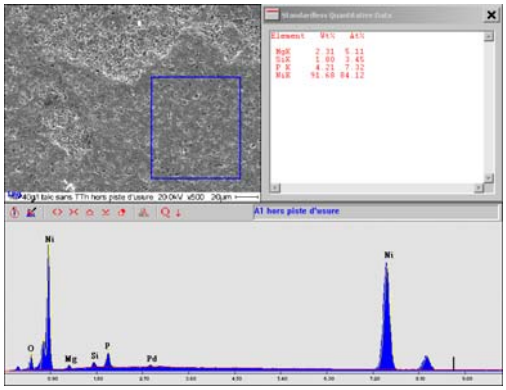

*Fig. 2. EDX diagram showing the chemical composition of the composite layer deposited (NiP + 40 g /l talc)*

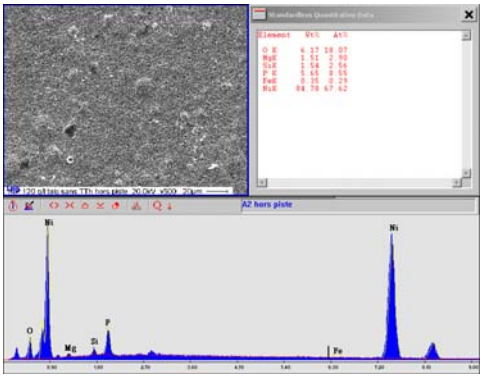

*Fig. 3. EDX diagram showing the chemical composition of the composite layer deposited (NiP + 120 g /l talc)*

### 3.2. Topography of deposited layers

Composite layers deposited surface topographies were made in white light interferometry method using an interferometer optical roughness type Veeco WYKO NT 1100. Analyzed surfaces allow lateral resolution of 1µm. Analysis of the deposited layer depth may reach 1 mm, without nanometer vertical resolution may be affected. Topographical observations were performed on three samples, one for each type of submission: chemical NiP, NiP 40g/l talc and NiP120g/l talc. Results are presented in Figures 4. By comparing values of the roughness, adding talc particles significantly increases the values of all the parameters that characterize the deposited layer roughness ($R_a$, $R_z$, $R_q$ and $R_t$).

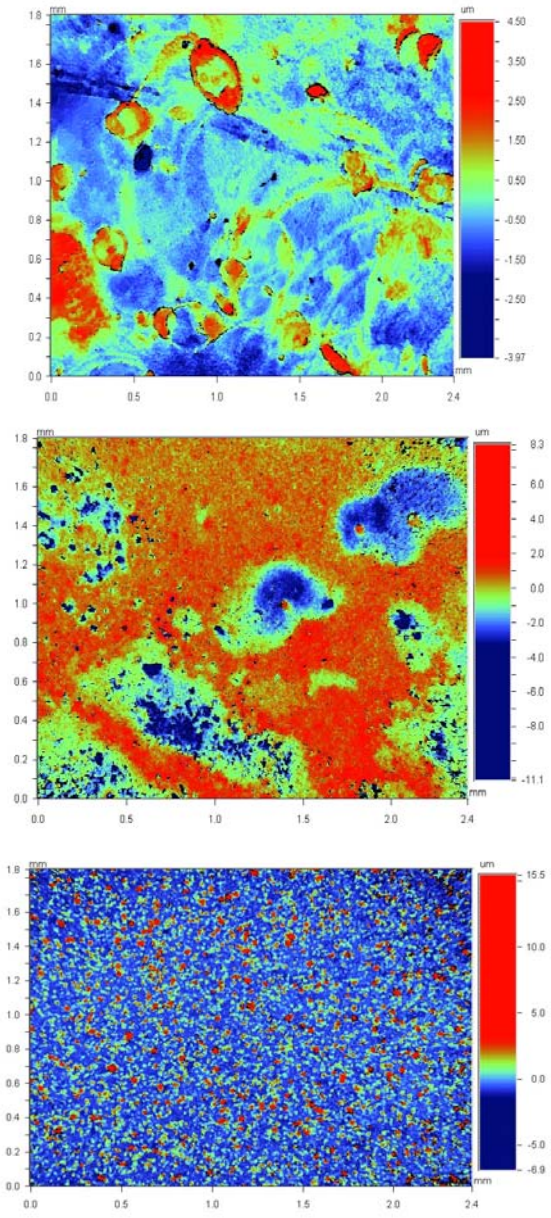

*Fig. 4. a) NiP composite coating raw and with b) 40g / l talc, c) 120g / l talc*

The values of roughness parameters are presented in table. 2.

*Table 2. The roughness characteristics*

| SAMPLE | $R_a$(nm) | $R_q$(μm) | $R_z$(μm) | $R_t$(μm) |
|---|---|---|---|---|
| NiP | 430 | 0.841 | 7.32 | 8.47 |
| NiP/40g/l talc | 893.71 | 1.21 | 14.74 | 19.43 |
| NiP/120g/l talc | 809.88 | 1.13 | 12.9 | 22.35 |

The variation of Ra parameter function of talc composition is presented in Fig. 5.

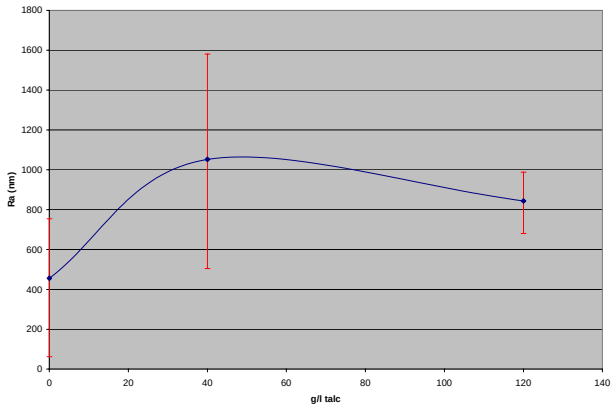


*Fig. 5. Variation of Ra*

The evolution of media roughness of deposited layers growth from NiP 0g/talc to NiP 40 g/l talc deposit and decrese again for NiP 120 g/l talc layer.

### 3.3. Morphology of the deposited layers

The surface morphology is highly influenced by the insertion of talc. In Figure 5 are shown micrographs deposited layers taken with a scanning electron microscope PHILIPS SEM 515, samples were prepared by palladium metallization.

Image analysis shows the influence of the presence of talc layer composite mass. If in absence of talc the surface layer is very smooth, in the presence of talc surface has been observed some bumps (nodules), due to agglomeration of talc particles in some areas. It can be seen especially in Figure 5 that these nodules increase as concentration increases talc in the composite layer deposition.

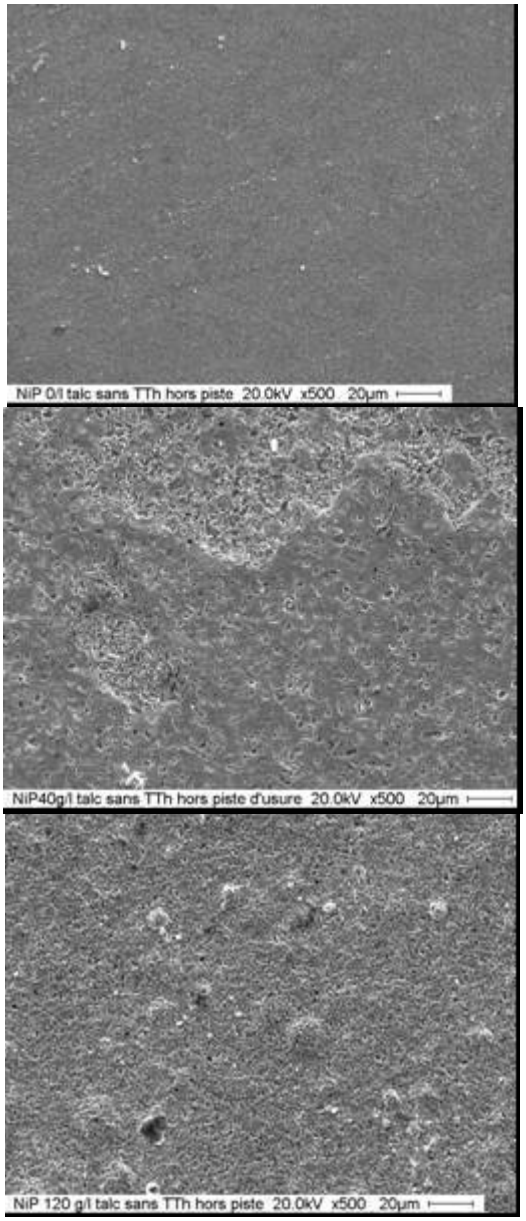


*Fig. 5. Different deposit morphologies (SEM micrographs, magnification × 500): a - NiP without talc, b - NiP + 40 g/l talc, c - NiP + 120 g/l talc*

## 4. Conclusions

The interferometry analyses show that the layers are characterizing by an irregular dispersion of talc particles for 40g/l talc. The irregularity is minimalizing for 120 g/l talc layer due to the uniform dispersion of talc particles. The morphologies put in evidence that at surface the layer present various irregularities due to talc because the talc is a hydrophobic substance. Therefore putting it in solution is quite difficult as talc particles tend to foam and crowding in contact with the liquid, affecting the final properties.

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