

ADHESION OF COMPOSITE MATERIALS

Minodora Maria Pasăre , Nicoleta Maria Mihuț

“Constantin Brâncuși” University, Tg-Jiu, minodora_pasare@yahoo.com

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Abstract: The nano-scratching studies the adhesion between the deposition of the composite material and substrate and provides details about the friction coefficient, depth of penetrating etc. The nanoscratching tests involving the movement of an indent, with constant speed, on a composite layer surface, driven by increasing normal force denoted L (load). For metal matrix composite layer of nickel-phosphorous with silicon carbide incorporated particles was obtained, after the nanoscratching test, a friction coefficient which has a nearly constant value of 0.35.

1. INTRODUCTION

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 [2-4].

Essentially, by compiling various materials, in different formulas, a new material can be created and the resulting synergistic properties of the material can be controlled. Thus, the challenge is to create a formula from which each ingredient interacts with one another to yield intended results. The composite material obtained is superior in mechanical properties, adhesion, corrosion, etc. Adherence composite is made by nano-scratching tests.

The scratch testing method is a very reproducible quantitative technique in which critical loads at which failures appear are used to compare the cohesive or adhesive properties of coatings or bulk materials.

The scratch test gives very reproducible quantitative data that can be used to compare the behavior of various coatings. The nano-scratching test is made on the sample with a sphere-conical stylus which is drawn at a constant speed across the sample, under a constant load, or a progressive load, with a fixed loading rate. The critical loads depend on the mechanical strength (adhesion, cohesion) of a coating-substrate composite but also on several other parameters [5]. The test specific parameters include: loading rate scratching speed, indenter tip radius, indenter material. The sample specific parameters include: friction coefficient between surface and indenter, internal stresses in the material for bulk materials, material hardness and roughness for coating-substrate systems, substrate hardness and roughness coating hardness and roughness coating thickness.

2. EXPERIMENTAL RESULTS

During nanoindentation the surface of a sample is displaced as pressure is applied by the tip of a probe. Analysis of the applied "Force-Displacement" dependence provides data on the hardness of a sample at a given point. One may analyze curves as well as topography of the images, by scanning the indented sample. Nanoscratching is a technique based on making scratches on the sample surface and measuring their parameters: depth and especially width. This gives an opportunity to evaluate the hardness of materials quantitatively. In some cases the results obtained can provide more information than that

obtained by nanoindentation, because the width of a scratch, as the result of the elastic recovery, modifies less than its depth.

The load-penetration-distance curves acquired during the scratching process at low velocity suggests that two deformation regimes can be defined, an elasto-plastic regime at low loads and a fully plastic regime at high loads. High resolution scanning electron microscopy of the damaged location shows that the residual scratch morphologies are strongly influenced by the scratch velocity and the applied load. Micro-Raman spectroscopy shows that after pressure release, the deformed volume inside the nanoscratch is mainly composed of amorphous silicon and Si-XII at low scratch speeds and of amorphous silicon at high speeds. Transmission electron microscopy shows that Si nanocrystals are embedded in an amorphous matrix at low speeds, whereas at high speeds the transformed zone is completely amorphous. Furthermore, the extend of the transformed zone is almost independent of the scratching speed and is delimited by a dislocation rich area that extends about as deep as the contact radius into the surface. To explain the observed phase and defect distribution a contact mechanics based decompression model that takes into account the load, the velocity, the materials properties and the contact radius in scratching is proposed [6].

The nano-scratching trying of the composite layers with a nickel-phosphorous metal matrix, including tough silicon carbide particles, is designed to study the adhesion between the deposition of the composite material and substrate and provides details about the friction coefficient, depth of penetrating, etc. tests The nanoscratching tests involving the movement of an indent, with constant speed on a composite layer surface, driven by increasing normal force denoted L (load) and performing three stages:

- a constant load $20\mu\text{N}$ crossing, through which is done the surface topography;
- the actual scratch test that it is carried out with a progressive increase of load;
- a constant load crossing, through which is realized the topography obtained from all scratches and is calculated the residual strain and elastic back.

The nano-scratching tests were performed on electrocoating layer of Ni-P metal matrix composite where were incorporated hard particles of silicon carbide. The sample was obtained containing 20 g/l of H_3PO_3 in the electrolyte and 80 g/l silicon carbide suspension. Variation of friction coefficient during the action of scratching or notching the surface deposits is shown in fig. 1 [1].

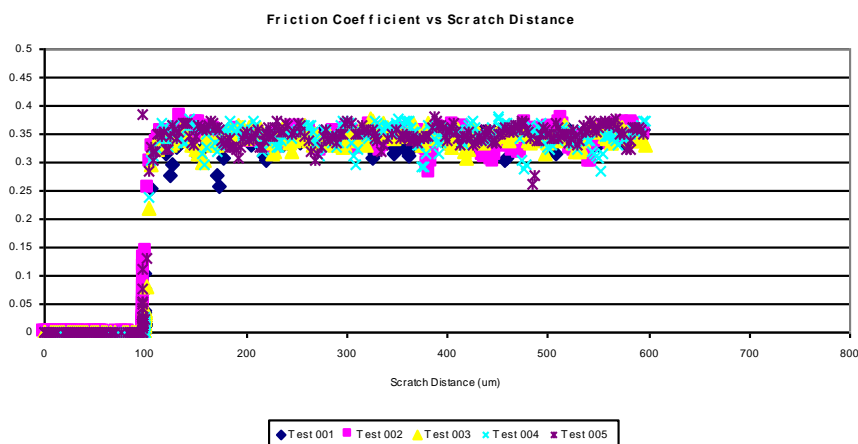
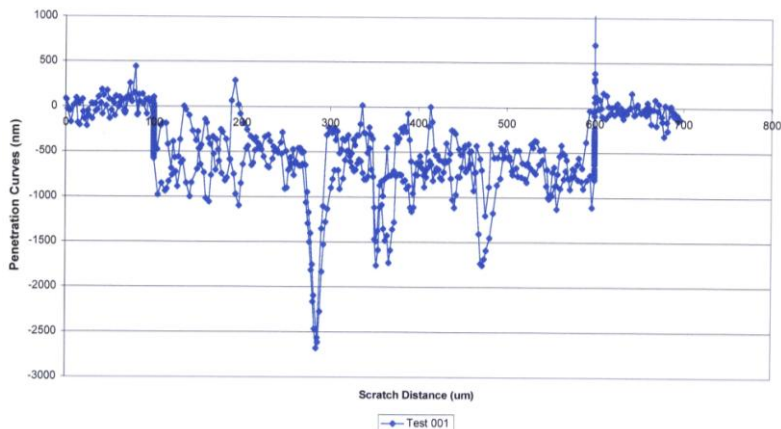
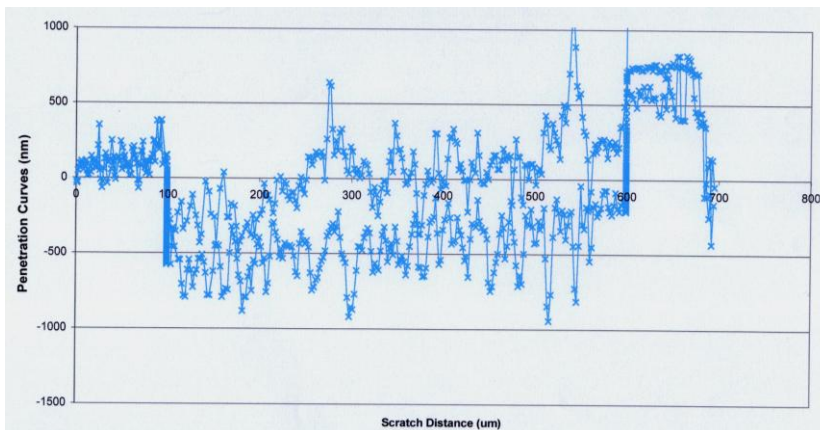


Fig. 1 Changes in friction coefficient for P20S80 deposition

During the nano-scratching test the friction coefficient remains almost constant at 0.35. The depth to which it produces the scratch and scratching topography are given in figure 2 a), b).



a)



b)

Fig. 2 a), b). Variation of depth and scratching distance for P20S80 deposition

3. CONCLUSIONS

The nano-scratching test performed show a good adhesion to the substrate layers, as confirmed by obtaining a penetrator-layer friction coefficient of 0.35. For the same applied load, the elastic back has different values, and the layer composite presents disturbances of the scratch profile due to the presence SiC particles.

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