Nanomechanical properties of C-Pd films

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Introduction

Nanostructural carbonaceous films containing nanograins of palladium (C-Pd films) are new materials with unique characteristics and structure in comparison with bulk Pd and carbonaceous macro-materials. Characterization of the nanomechanical properties such as nanohardness, the reduced modulus or delamination of new nanomaterials is particularly interesting because of their possible implementation in hydrogen applications and hydrogen compounds sensors. Because of the potential application of such films in various kinds of sensors, it is important to know their mechanical properties. Even a small change of composition or form of nanomaterials affects their properties due to a change of material structure, morphology and surface topography. Additionally superficial and near surface properties have a huge impact on all material character because of a big surface to volume ratio.

Experimental

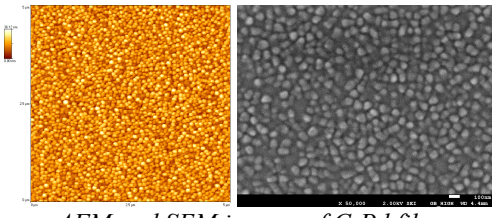
C-Pd films were obtained by PVD method. These processes were done from two separated sources. One containing C_{60} fullerenes and other containing palladium acetate. PVD processes were conducted in a dynamic vacuum of 10^{-5}mbar [1].

Depending on parameters of the technological process such as current intensity through sources, sources-substrate distance or deposition time samples with various thickness and Pd content were obtained.

In this work we present the results of topographical studies (AFM, SEM), results of nanoindentation experiment and scratch test for several films with different palladium content.

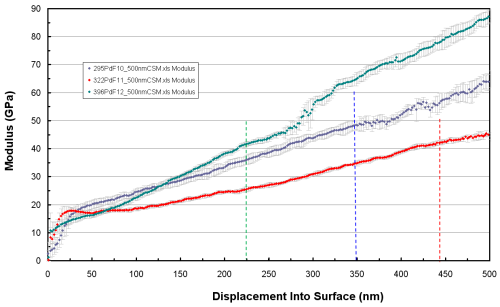
Results

AFM and SEM images of studied samples are presented in Fig.1.



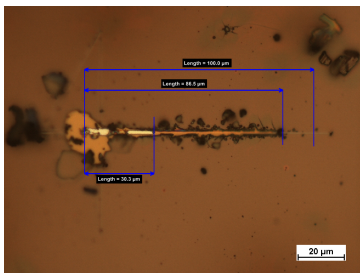
AFM and SEM images of C-Pd film

The characterization of the surface mechanical properties of thin films was investigated by Agilent Nano Indenter G200. All experiments were performed with a Berkovich tip made of diamond. The continuous stiffness measurement (CSM) technique was used to study the contact stiffness, elastic modulus, hardness and creep behavior of C-Pd films. The elastic modulus as a function of displacement into surface are shown in Fig. 2.



Elastic modulus as a function of displacement into surface of different C-Pd films

In order to determine the adhesion C-Pd film to the substrate nanoscratch test was used.



Graph of the scratch at C-Pd film

We found that mechanical properties of C-Pd films depend on the content of palladium initially introduced and also depend on the topography of these films.

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