DSCM 22P HARDNESS OF THE Cu THIN FILMS GROWN ON THE MgO SUBSTRATE

D. Grabco[1], C. Pyrtsac[1], L. Ghimpu[2]
[1]*Institute of Applied Physics, Academy of Sciences of Moldova, Chisinau, Moldova*
[2]*Institute of Electronic Engineering and Nanotechnologies, Academy of Sciences of Moldova, Chisinau, Moldova*
*E-mail: grabco@phys.asm.md

During the process of growth and exploitation of films can occur the strong internal tensions that after relaxation may cause its deformation and destruction. Thin films – means the existence of a substrate of other materials with properties differing from film material. Therefore mechanical properties of thin films depend also on the features of substrate [1].

In this paper we studied the mechanical properties of Cu thin films grown on MgO (4) substrate. The Cu films were obtained by the method of magnetron sputtering (with Magnetron Sputtering RF) at room temperature with thickness t=85 (1), 470 (2), 1000 (3) nm. The roughness, R_a, of the surface of thin films was estimated using the atomic force microscope and optical microscopes. The results are shown in Table 1.

Table 1. The thickness (t) and roughness (R_a) of Cu films

Sample		Thickness (t), nm	Roughness (R_a), nm
Cu	1	85	56
	2	470	21,2
	3	1000	18,7
MgO	4	-	8,8

Nanoindentation was carried out on the Nanotester-PMT-3-NI-02 using the dynamical regime of penetration. The loads on the Berkovich indenter varied in the limits P_{max}=2÷900 mN. For the calculation of the Young elastic modulus (E) and hardness (H) of the thin films was used the method proposed by Oliver-Pharr [2]. The H and E values were evaluated as the mean of five indentations applied at the same load. Fig. 1 shows the dependences of H and E as a function of applied load.

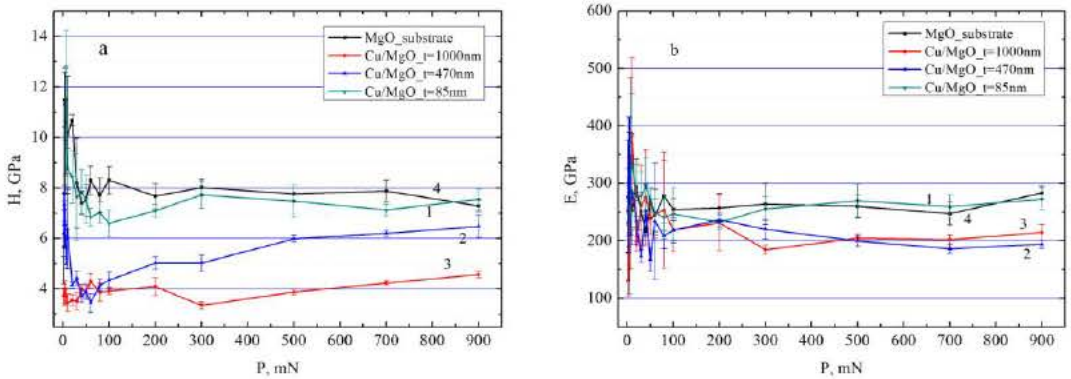

Fig. 1. Dependences *H(P)* (a) and *E(P)* (b) for the *Cu/MgO* complex structures (1), (2), (3) and for the MgO substrate (4).

From the data above we see that the roughness Ra decreases with increase of film thickness (Table 1). Hardness and Young's modulus of the Cu/MgO composed structure also depends on film thickness, these parameter values decrease with increase of the film thickness (Fig. 1). One of the reasons of this effect can be the indenter tip change. The film changes the indenter geometry, indenter tip becomes more obtuse when film thickness increase and it's action becomes softer.

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[2]. W. C. Oliver, G. M. Pharr. *J. Mater. Res.,* 1992, **7**, 6, 1564-1583