CPPP 17 P VISUALITATION OF UNDULATORY MASS TRANSFER IN NEAR-SURFACE VICINITY OF INDENTATION CONTACT ZONE

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Deformation regularities of crystals, films and coated systems assume ever greater importance in recent years. Particularly, it concerns the micro- and nanoindentation processes because of their large practical application.

The microstructure of deformed zones under quasistatic nano-microindentation of some of coated systems (Cu/LiF, Cu/MgO, ITO/Si, SnO_2/Si) was considered in the work to study the deformation specificity of coated systems as a whole, comparing their behaviour with this of the bulk crystals (LiF, MgO, Si) used as substrate. It was revealed plastic round pile-ups of material near indentations on both the bulk single crystals and coated systems (Fig. 1-3).

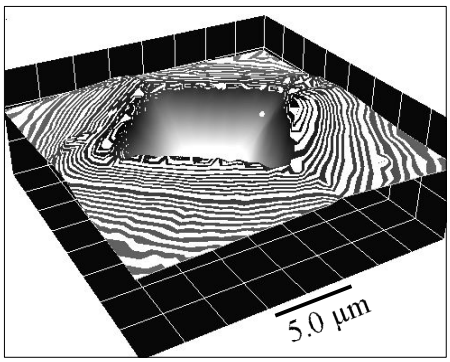

Fig.1. Si. Computer rendering of AFM image of the surface relief near indentation. *P*=0.2 *N*.

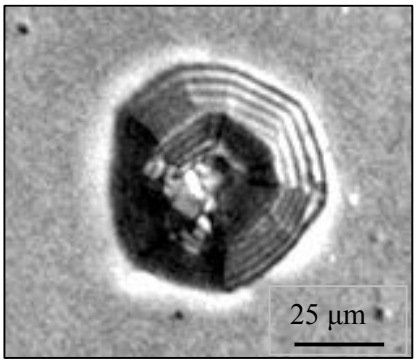

Fig.2. SnO_2/Si. Light microscopy image of the pile-up zone near indentation. *P*=0.4 *N*

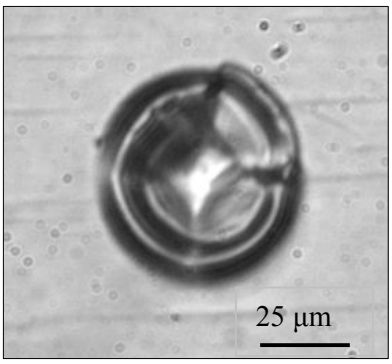

Fig.3. Cu/MgO. Light microscopy image of the pile-up zone near indentation. *P*=0.4 *N*

The circular arrangement of material in the deformed zone near indentations was also detected on the ITO/Si coated system after short-term polishing in the concentrated HF acid. The circular pattern became clearer after the full removal of film and extended on some depth in the Si-substrate bulk. The circular shape of the deformed zone around indentation after film removal was detected on the SnO_2/Si, as well. The undulatory surface relief was also revealed at the AFM studying of the deformed zones around indentations made on the LiF, MgO and Si bulk crystals (Fig.1). One can conclude that oscillating character is a common feature of the kinetics of elastic-plastic deformation under nano- microindentation. At the same time, it was observed the effect is more pronounced in the coated systems then in bulk crystals.

The detected patterns of the concentric slipping in the studied coated systems and circular material arrangement in the bulk substrates near indentations are consistent with the theoretical trajectories of maximal shear stresses of the oscillating character determined in elasticity theory for the case of concentrated load action on a semi-infinite plate boundary [1]. The revealed effect allows making a supposition about the undulatory elastic-plastic transfer of material in the area of maximal shear stresses under a local load action, in general, and under nano- microindentation, in particular.

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Reference

[1] M.M.Frocht. Photoelasticity // J.Willey and Sons,1948, v.II, Nr.9