MULTIFUNCTIONAL SCANNING PROBE MICROSCOPY FOR HARD COATING CHARACTERIZATION

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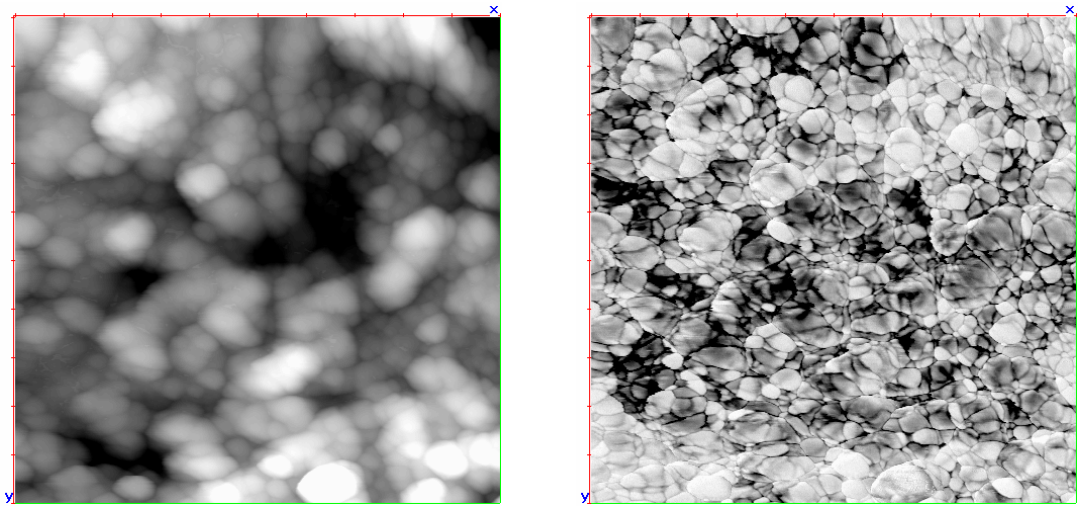
The paper describes new approaches to comprehensive characterization of hard coatings with SPM and trends in development of SPM techniques that are realized on the base of AFM NT-206 (HMTI, Microtestmachines Co, Belarus).

Contrast imaging. Practically all modern scanning probe microscopes along with common SPM images of surface topography allows simultaneous obtaining of additional contrast images of the measured area [1–3]. Contrast images usually give information about heterogeneity of surface properties over the researched object. [4] (Fig. 1). Joint visualization of topography and micromechanical properties map over the researched surface area allows understanding, for example, of the phenomena having place at friction (Fig. 2).



a) b)

Fig. 1. AFM images of topography (a) and surface structure measured by phase imaging (b) for CrO^2 coating. Scan 9.7x9.7 um

Dynamic force spectroscopy. The authors made an attempt to use dependence of probe oscillation amplitude on the tip–surface separation to estimate local elastic modulus for the areas differing by contrast on the phase shift image that is application of dynamic force spectroscopy to characterize heterogeneous surface of diamond-like coating (DLC) on silicon substrate.

Nanotomography. One of perspective directions of SPM technique development is their adaptation for obtaining information about subsurface nanostructure of materials. Non-destructive techniques certainly have advantages for the researchers. Such techniques are based on mechanical interaction of the microtip with sample surface of investigated material under contact and hard intermittent modes that results in local deformation, meanwhile, the material is deformed elastically and its layers do not undergo irreversible changes at the measurement. To illustrate that, we investigated diamond-like coating. The analysis reveals inner structure of the coating that contains sets of columnar diamond-like clusters covered by layer of non-structured carbon.

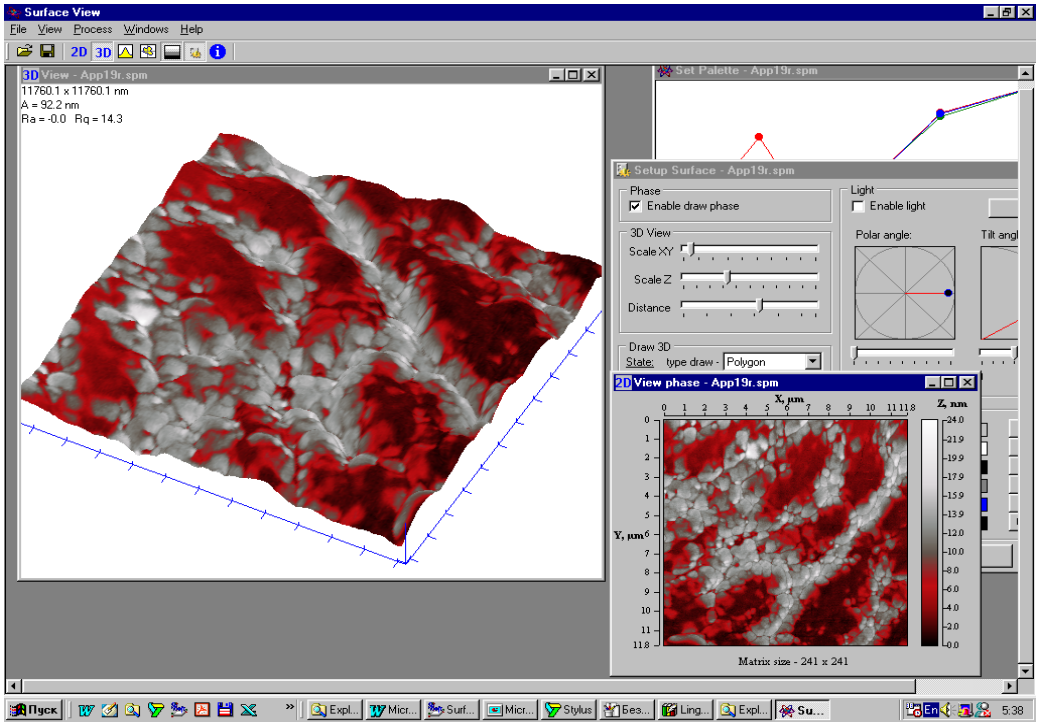


Fig. 2. Visualization of graphitized films on DLC coating produced by the surface friction [5].

Nanowear. To estimate wear resistance of coatings, destructive techniques that employ AFM probes with diamond tip can be engaged. In this case measured is dependence of the pulled-off material thickness on load applied to the probe. To visualize the wear test results, the same probe is used to scan the researched surface area.

Oscillating tribometry. Newly developed is a procedure of oscillating tribometry realized as option for AFM NT-206 [6]. Such procedure can be successfully applied as fast test for surfaces of microparts under conditions close to the actual ones.

Conclusion. Quantitative characterization of surfaces performed to estimate local mechanical properties at nanometer resolution is a complex problem that can be successfully worked out with help of SPM techniques.

Measurements in nanometer scale level with scanning probe microscopes with employment of newly developed procedures are not trivial for a while and demand to realize quite complex functions for calibration, recognition and elimination of artifact off the images. Despite intensive development of SPM, the method's capabilities still remains unexhausted.

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