TEM imaging of tip-sample contacts between microfabricated silicon tips and copper surface

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A scanning probe microscope (SPM) inside a transmission electron microscope (TEM) seems to be attractive tool for direct investigation of interactions at nanoscale (see, for instance, [1] and references therein). As the shape of the tip and sample and actual size of the geometry of contact area during the SPM experiment are unknown, a possibility of an additional visual control using TEM is very important. While in the common used SPMs the cantilever displacement is controlled by optical system, in the TEM the tip motion is directly imaged. A visualization of the geometrical shape of the cantilever during the scan process allows to get information on normal/lateral forces applied, the cantilever stiffness, material properties and their comparing with technical characteristics of commercial tips. In this work we used TEM TESLA BS–250 with operating voltage of 40 – 60 KeV, electron current of 0.08 – 0.12 mA and working pressure of 10^{-3} *Pa* In order to see the contact spot we employed the shadow operating regime. The sample was made of copper wire with a diameter of 0.15 mm. The tips were taken to be microfabricated Au-coated silicon ones produced by NT- MDT Co (see Fig.1). The 3–dimensional piezodrive enables the tip to get moving along coordinates (x,y,z). By displacing the tip along the surface it was possible to visualize the contact region. The images were photographed using commercial video chamber. During the scans we have observed real time tip–sample deformations, changes of contact geometry and ploughing effects (see Figs.2,3)

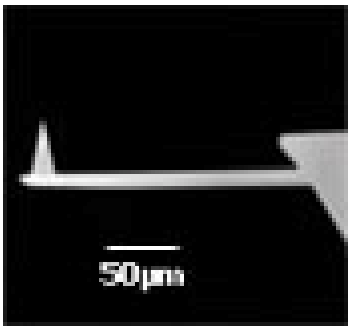

Fig.1 NT-MDT Si cantilever

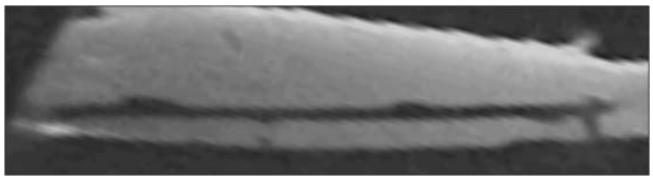

Fig.2 Small applied normal force

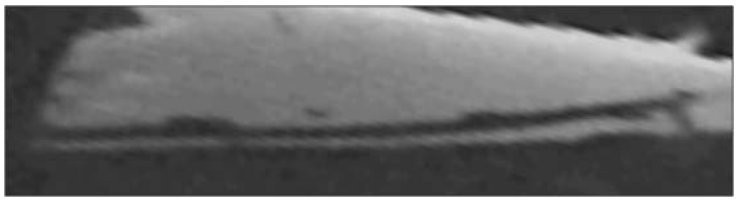

Fig.3 Large applied normal force

[1] R. Lohmus, D.Erts, A.Lohmus, K.Svensson, Y.Jompol, and H.Olin, Phys. Low-Dim. Struct. 3/4 (2001)81.