ESF Short Visit Grant

Reference number 586

Activity Title Nanotribology

Title of the proposed research project

Control of Friction at the Nanoscale

During my visit of Leiden University I gave a lecture: “Atomic Scale Friction: From Understanding to Control”. In this lecture I discussed different theoretical approaches used for interpretation of friction measurements at the nanoscale. I have demonstrated that the “minimalistic” approach, which is based on an explicit description of few degrees of freedom of the driven system, not only allows to describe observed phenomena, but also lead to predictions, some of which have been already observed experimentally. Then I discussed new ways to control friction at the nanoscale focusing on application of the mechanical excitations of small amplitudes. It has been demonstrated that manipulations by mechanical excitations when applied at the right frequency and amplitude can dramatically reduce friction.

During the visit I have discussed with Prof. J. Frenken, Dr. S.Yu. Krylov and K.B. Jinesh a possibility to apply our theoretical models for interpretation of tribological measurements performed in Leiden. The following problems have been discussed:

1. thermally induced suppression of friction;
2. effect of capillary forces on friction;
3. effect of mechanical vibrations of friction.

Our recent theoretical models [1,2] can be used to treat experimental results (1,3). It should be noted that the experiments on thermolubricity performed in the laboratory of Prof. Frenken stressed an importance of 2D motion of AFM tip along the surface. New frictional phenomena found in the case of water layers required new theoretical models. We are planning to perform these studies in Tel Aviv University.

During my stay in Leiden I have also visited groups working on dynamics of vortexes, granular materials and biologically related problems. The studies performed in these groups are strongly related to the tribological problems, and their experience is very useful for a solution of still unresolved tribological problems. We are planning to apply the theoretical models developed in studies of dynamics of vortexes for description of dynamics of friction at the nanoscale.

1. Dudko O., Filippov A.E., Klafter J., Urbakh M., Beyond the conventional description of dynamic force spectroscopy of adhesion bonds, Proc. National Academy of Sciences USA, 100, 11378–11381 (2003)
2. Tchiprut Z., Filippov A.E., Urbakh M., Tuning diffusion and friction in microscopic contacts by mechanical excitations, Phys. Rev. Lett. 95, Art. 016101 (2005).

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