MAR06-2005-004358

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Superlubricity and atomic-scale energy dissipation in ultrahigh vacuum[1]

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"Superlubricity" has been recently achieved on ionic crystals in ultra-high vacuum in two different ways. First, the normal load exerted by a sharp AFM tip on the crystal surface has been reduced below a critical threshold under extremely low noise conditions, and kept constant while scanning in the usual way. The transition from the stick-slip motion commonly observed on the atomic scale to the superlubricated regime occurs in a continuous way, and can be theoretically described introducing a parameter η, which is, respectively, larger or smaller than 1 in the two regimes. A comparison with the Tomlinson model allowed us to carefully estimate the contact stiffness and the interaction between tip and surface down to the superlubricated regime [1]. The "static" superlubricity obtained in such way cannot be easily extended to systems of practical interest, like micro- and nano-electromechanical devices. The main problem is the smallness of the applied loads (below 1 nN), which must be maintained for a long time. This obstacle is removed if superlubricity is achieved in a different "dynamic" way. When an *ac* voltage is applied between the tip and a counterelectrode on the other side of the crystal sample, and the actuation frequency corresponds to a normal resonance of the system, a sistematic decrease of friction to negligible values is also observed. In such case the magnitude of the applied load is not subject to upper limitations. This effect is probably due to a delicate interplay between thermal activation and the fast variation of the tip-surface interaction, as suggested by recent computer simulations.

[1] A. Socoliuc, R. Bennewitz, E. Gnecco, and E. Meyer, Phys. Rev. Lett. 92 (2004) 134301

[1]The Swiss NCCR-Nanoscale Science is gratefully acknowledged.