Angular dependence of static and kinetic friction on alkali halide surfaces

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The angular dependence of the lateral forces acting on an atomically sharp tip slowly pulled by an elastic spring along a crystal surface with square symmetry is investigated in the framework of a separable two-dimensional tip-surface interaction potential. In the stick-slip regime kinetic friction is proportional to (cos phi + vertical bar sin phi vertical bar), phi being the angle between the scan direction and a particular symmetry axis. For a high enough normal force, static friction is proportional to 1/cos phi, whereas for intermediate loads it shows a phi-dependent spread of possible values. Continuous sliding with ultralow friction sets in below a load-dependent corrugation amplitude. Numerical simulations help interpret those analytic results in terms of the zigzag motion of a friction force microscope tip sliding on the (001) surface of a rocksalt crystal. The influence of the offset between the start of a scan and the center of the corresponding unit cell, in particular, for scans along <100 >directions is also elucidated. The predicted ratio of kinetic friction along the <100 >and <110 >directions agrees best with values measured on alkali halides with similar cation and anion radii. This ratio, as well as the angular dependence of the static friction may be used to determine fine details of the lateral tip-sample interaction.

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