Atomic Structure Affects the Directional Dependence of Friction

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Friction between two objects can be understood by the making, stretching, and breaking of thousands of atomic-scale asperities. We have probed single atoms in a nonisotropic surface (the H-terminated Si(100) surface) with a lateral force microscope operating in noncontact mode. We show that these forces are measurably different, depending upon the direction. Experimentally, these differences are observable in both the line profiles and the maximum stiffnesses. Density functional theory calculations show a concerted motion of the whole Si dimer during the tip-sample interaction. These results demonstrate that on an asperity-by-asperity basis, the surface atomic structure plays a strong role in the directional dependence of friction.

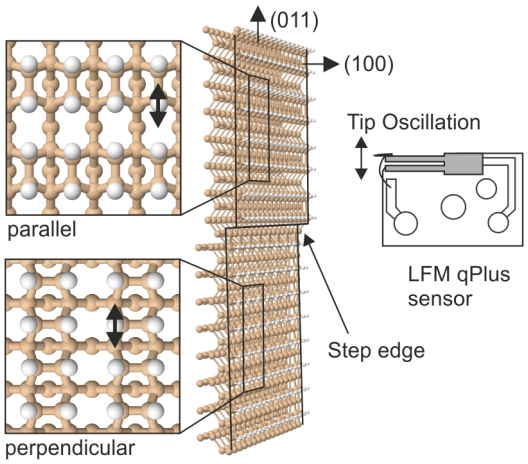

Figure 1: Schematic of the experimental setup. By cutting the Si wafer on the {011} planes, the (011) crystallographic direction can be aligned with the tip oscillation. By moving from one terrace to another, data can be acquired with the tip oscillating either parallel or perpendicular to the Si dimers.

References

A.J. Weymouth, D. Meuer, P. Mutombo, T. Wutscher, M. Ondráček, P. Jelinek and F.J. Giessibl, Phys. Rev. Lett., accepted 2013