

Energy Dissipation on Graphite in Dynamic Force Spectroscopy

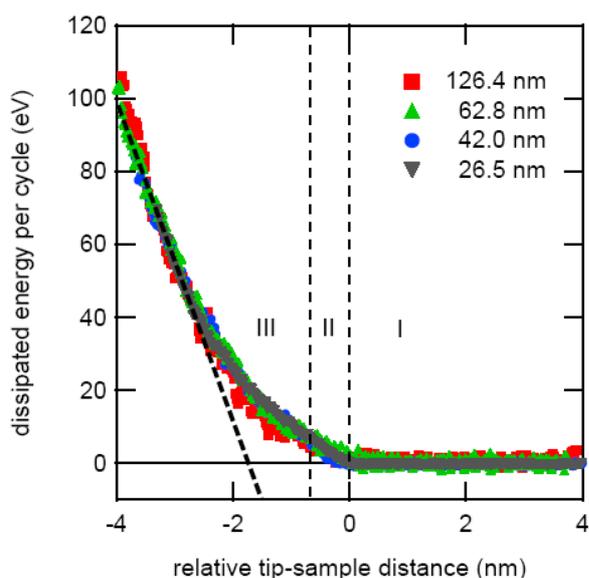
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Dynamic force spectroscopy (DFS) measurements under ultrahigh vacuum (UHV) conditions are useful to get detailed information about tip-sample interactions. Conservative as well as dissipative forces can be measured, where especially the dissipation processes are up to now not well understood and still under debate. In our work we investigate the dissipation and its underlying mechanism in dependence of two parameters: the relative tip-sample velocity and the sample temperature.

Force spectroscopy experiments were performed using a variable temperature nc-AFM in UHV. We examined the velocity dependence of the dissipation on HOPG by varying the oscillation amplitude of the cantilevers [1,2]. We found that the dissipation on graphite increases monotonically with decreasing distance between tip and sample and that the magnitude of the dissipation is independent of the oscillation amplitude. Hence we conclude that the dissipated energy does not depend on the relative tip-sample velocity [2]. This gives



The figure shows energy dissipation curves for a silicon tip on graphite for different oscillation amplitudes (taken from [2]).

further evidence to the idea that adhesion hysteresis governs dissipation processes.

In contrast, using small cantilever amplitudes at low temperatures Hembacher et al. [4] found a step like increase of the dissipation signal when the tip contacts the graphite surface. Recent theoretical work also indicates that a sharp increase in the dissipation at close distances between tip and sample should occur at low temperatures [3]. However, the theory predicts a clear temperature dependence with a step like behaviour at 100 K and a comparably smooth increase at 300 K.

Therefore we have measured the dissipation on HOPG at different sample temperatures ranging from 30 K to 300 K. In this contribution we will discuss the influence of the temperature on the dissipation spectroscopy curves.

- [1] A. Schirmeisen, et al., *Nanotechnology*, 16, 13-17 (2005)
- [2] A. Schirmeisen, et al., *Phys. Rev. B* (2005) in press
- [3] L.N. Kantorovich, et al., *Phys. Rev. Lett.*, 93, 236102 (2004)
- [4] S. Hembacher, et al., *Phys. Rev. Lett.*, 94, 056101 (2005)