AFM-studies of humidity dependence of friction in graphene and other 2D materials

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Nanotribology is a subfield of nanoscience and tribology that investigates frictional and wear properties in nanoscale systems. Many applications of nanotechnology are plagued by frictional phenomena that arise from their inherently large surface-to-volume ratios. Research in the field of nanotribology is hence necessary to advance nanotechnology for the purposes of practical applications. The tip of an Atomic Force Microscope (AFM) provides a controllable single-asperity probe for direct nanoscale investigation of friction. Specialized AFM imaging modes exist for the study of frictional properties of surfaces. In Lateral Force Microscopy (LFM), the torsion of an AFM cantilever due to lateral forces is recorded to acquire the frictional profile of the surface.

We have carried out nanotribological LFM measurements under the conditions of varying humidity with an environment-controlled AFM instrument [1]. In addition to measuring the mean values of lateral force (LF), force-displacement (F-Z) curves were obtained. The investigated surfaces have included low-friction coatings graphene, molybdenum disulfide, (MoS_2, Fig. 1) and diamond-like carbon, DLC [2] as well as hydrophilic- and hydrophobic-treated silicon [3]. For these coatings, our measurements suggest a trend of decreasing friction with decreasing humidity. For the Si samples, drastic difference emrges between hydrophilic and hydrophobically treated surfaces.

References

[1] J. Lievonen, K. Ranttila, and M. Ahlskog, Review of Scientific Instruments, **78** (2007) 043703.
[2] M. Hokkanen et al, unpublished.
[3] J. Lievonen, Ph.D Thesis, Univ. of Jyväskylä, Dept. of Physics, Research Report 8 (2011).

Figures

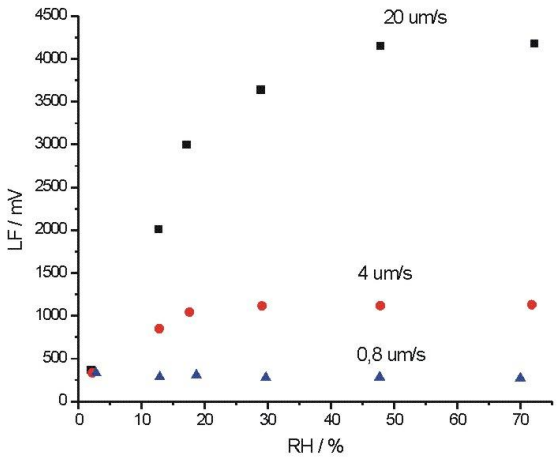

Figure 1. Lateral force measured as a function of relative humidity with three different scanning speeds for MoS_2-Ti.