Atomic-scale friction on MoS2 layers strained by surface roughness, thermal contraction and vacancy defects

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Friction force microscopy (FFM) is a very suitable tool to investigate the mechanical shear response of solid surfaces down to the atomic scale. After pioneer applications of this technique to bulk crystal surfaces, significant research has been conducted on the nanofriction of two-dimensional (2D) systems, such as single or double layers grown on a crystal substrate. Noticeable examples are the moire patterns observed in the frictional maps of KBr on NaCl [1] or graphene on SiC [2] and unambiguously related to the superstructures formed by these systems. However, it appears that atomic-scale details are rarely accessible in FFM investigations on more irregular 2D systems.

In this contribution we have focused on MoS2 layers prepared on amorphous SiO2 with different techniques, and attempted to relate the nanotribological response of MoS2to the surface strain caused by (i) the roughness of the MoS2/SiO2 interface, (ii) the shear stress bands and even cracks caused by the different thermal expansion coefficients of the two materials, and (iii) the possible presence of atomic-scale vacancies. Investigations on heterostructures formed by MoS2 and WS2 are also in progress.

[1] S. Maier et al., Atomic-scale friction modulated by a buried interface: Combined atomic and friction force microscopy experiments, Phys. Rev. B 78 (2008) 045432

[2] T. Filleter et al., Friction and dissipation in epitaxial graphene films, Phys. Rev. Lett. 102 (2009) 086102