Electrical and Mechanical Properties of Atomically Thin Layers of MoS_2

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Abstract

Two-dimensional crystals are promising materials for next-generation flexible electronic devices. Although graphene is by far the most studied two-dimensional crystal, its lack of a bandgap hampers its application in semiconducting and photonic devices. A large bandgap is a requirement, for instance, to fabricate field-effect transistors with a large current on/off ratio and low power consumption. In contrast to graphene atomically thin MoS_2 crystals show a large intrinsic bandgap making it a potentially interesting material for electronic devices and sensors.

In this talk I will present our recent results on the mechanical and electrical properties of this material. In particular, we have studied the elastic properties of MoS_2 in freely suspended nanosheets, with thicknesses ranging from 5 to 25 layers using atomic force microscopy [1] and the electrostatic screening by single and few-layer MoS_2 sheets by means of electrostatic force microscopy [2].

References

[1] Andres Castellanos-Gomez, Menno Poot, Gary A. Steele, Herre S. J. van der Zant, Nicolás Agraït, and Gabino Rubio-Bollinger, Elastic Properties of Freely Suspended MoS_2 Nanosheets, Adv. Mater. **24**, (2012) 772–775.

[2] Andres Castellanos-Gomez, Emmanuele Cappelluti, Rafael Roldán, Nicolás Agraït, Francisco Guinea and Gabino Rubio-Bollinger, Electric field screening in atomically thin layers of MoS_2: the role of interlayer coupling, Adv. Mater. **25**, (2013) 899–903.

Figures

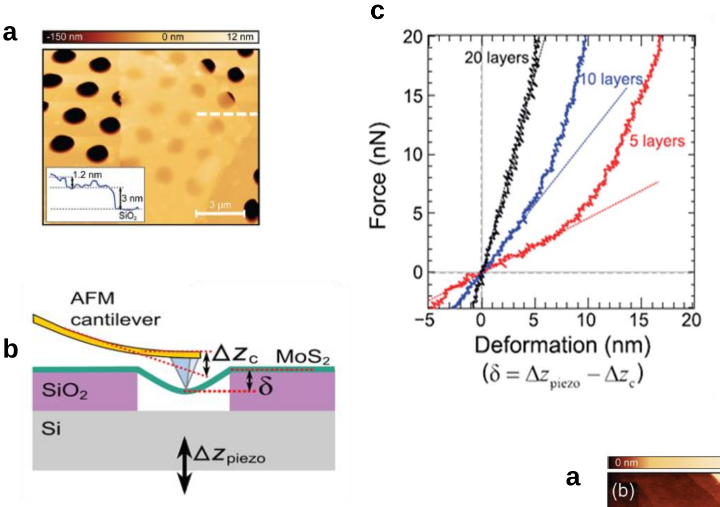

Figure 1. a AFM topography of a 3-4.2-nm-thick (5-7 layers) MoS_2 flake deposited on top of a 285 nm SiO_2/Si substrate pre-patterned with an array of holes 1.1 μm in diameter. Inset: Topographic line profile acquired along the dashed line. **b** Schematic diagram of the nanoscopic bending test carried out on a freely suspended MoS_2 nanosheet. **c** Force versus deformation traces measured at the center of the suspended part of MoS2 nanosheets with 5, 10, and 20 layers in thickness.

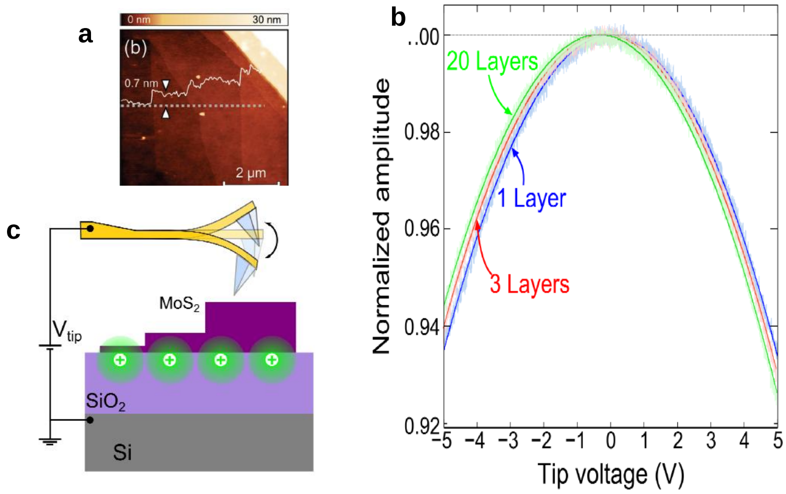

Figure 2. a Topographic AFM image of the region studied showing regions of 1,2 and 3 layers. **b** Normalized cantilever oscillation amplitude as a function of the applied tip-sample bias voltage, measured in the 3 regions. **c** Schematic of the EFM measurement setup.