Nanopatterning on atomically thin TaS_2 conducting layers

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Since the discovery of graphene, a lot of effort has been made to integrate atomically thin layers in the fabrication of ultrathin, transparent and flexible electronic devices .[1] The fundamental advance in this area has been feasible thanks to the micro-mechanical exfoliation methods.[2] In this context, 2D crystals such as transition metal dichalcogenides have shown excellent exfoliation mechanism and offer a wide variety of properties that could match or even outweigh the properties of graphene.

In this work we will first report on the controlled chemical modification of ultrathin TaS_2 layers by means of AFM Local Oxidation Nanolithography (AFM-LON). TaS_2 crystals were exfoliated by a novel technique based on the controlled application of shear forces between the 2D crystal and the substrate. Atomically thin TaS_2 layers, which are metallic at room temperature and superconducting at low temperatures, were conveniently nanopatterned with an unprecedented precision and reproducibility achieved thanks to the development of a new LON modality, named by us as *static-tip* LON. This possibility opens the door for the nanofabrication of devices and furthermore, for the fundamental study at low temperature of the physical consequences derived from the confinement at the nanoscale of this layered superconductor. It was also found unseen rippled mound morphologies in the oxidation process of TaS_2 flakes. This behaviour is novel and may be inferred from the peculiar Fermi surfaces of these bidimensional systems.

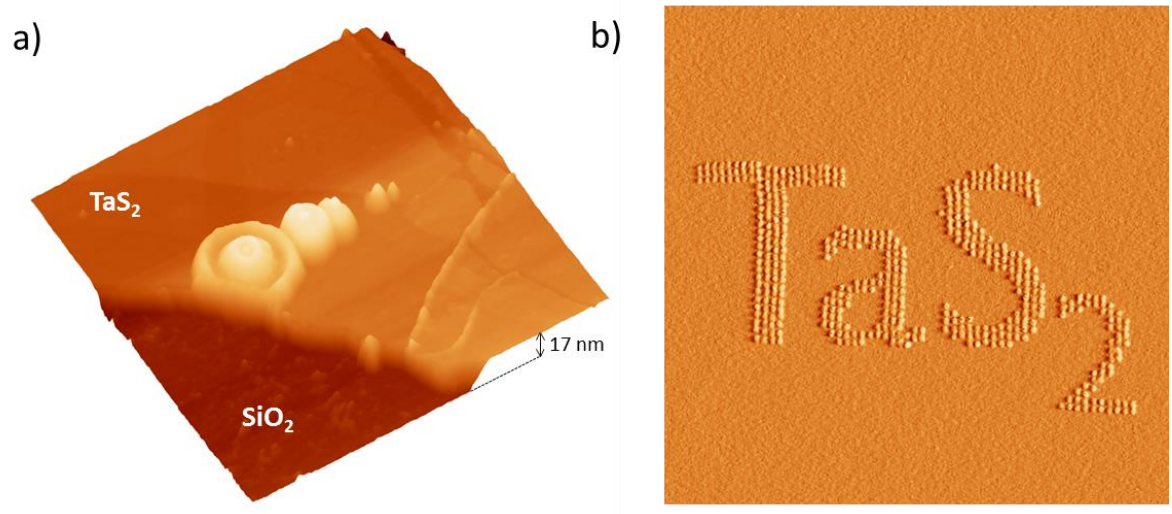

Figure 1. a) 3D representation of an array of 5 rippled mound patterns oxidized on a 17 nm thick flake. Image size: 2.5 µm x 2.5 µm. b) *Static-tip* AFM-LON performed on the surface of TaS_2 flake. Image size: 3.5 µm x 3.5 µm.

[1] K. S. Novoselov, A. K. Geim, S. V. Morozov, D. Jiang, Y. Zhang, S. V. Dubonos, I. V. Grigorieva, A. A. Firsov, Science, **306** (2004), 666.

[2] K. S. Novoselov, D. Jiang, F. Schedin, T. J. Booth, V. V. Khotkevich, S. V. Morozov, A. Geim, K. Proc. Natl. Acad. Sci. U.S.A., **102** (2005), 10451.