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Atomic Force Microscopy (AFM) nanopatterning of 2D materials

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Abstract

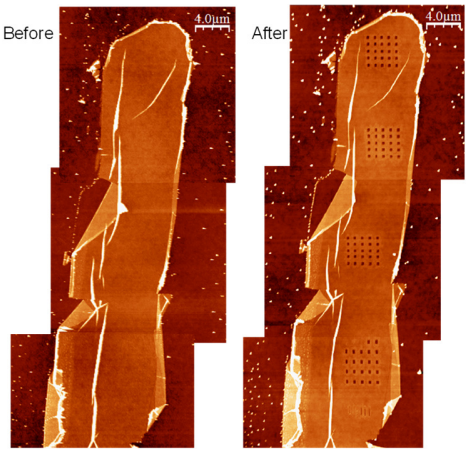
The isolation of graphene has opened the door to a wide variety of 2D materials with many interesting properties. The fabrication of devices incorporating 2D materials involves a number of steps, including their patterning on the nanometer scale. Standard lithographic techniques are commonly used for this purpose, but they tend to leave contamination on the samples.

In this project, we will use atomic force microscopy (AFM), a scanning probe technique that uses a very sharp tip at the end of a microcantilever as a force sensor, for nanopatterning of 2D materials. AFM allows one to "see" at the nanoscale, as blind people do with their canes, and also provides valuable information about various physicochemical properties of a wide variety of systems. Importantly, the tip can also be used to make nanometer-scale modifications to samples [1].

The student will first learn how to mechanically exfoliate graphene and how to characterize it optically and by means of AFM. Then he/she will use the lithographic capabilities of the AFM to fabricate contamination-free nanodevices by patterning graphene after local etching of selected areas [2] (see figure below for an example). Remarkably, the AFM can produce features as small as 10 nm. Finally, he/she will explore the possibility of using this technique to nanopattern other 2D materials, such as MoS_2, a promising candidate for two-dimensional electronics due to its semiconductor character. The Nanoforces group has a long experience in AFM/STM design and fabrication. The student will also benefit from this experience along the TFM.

References:

1. Moreno-Moreno & Ares *et al.*, Nano Lett. 2019, 19, 5459-5468.
2. Li *et al.*, Nano Lett. 2018, 18, 8011-8015.



Example of nanopatterning of few-layer graphene. Typical lateral size of the lithographed motifs in the figure is 300 nm.