2D Papertronics: electronic devices based on two-dimensional materials on paper substrates

Basic information:

Place: Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC, campus UAM)

Research Group: 2D Foundry (https://sites.google.com/view/2dmaterialsanddevices)

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Introduction

Handwriting and/or drawing on a piece of paper with a pencil has become a routine daily task for thousands of millions of people around the world due to their mass production that led to ubiquity and reduced cost. These common stationery items have recently jumped out of the writing/drawing realm and have been employed to fabricate electronic devices. This has been, most likely, motivated by the extremely low cost of paper substrates (paper ~0.1 € m^{-2} as compared with PET ~2 € m^{-2}, PI ~30 € m^{-2} and crystalline silicon ~1000 € m^{-2}) its biodegradability and its potential to allow the fabrication of flexible and even foldable electronic devices.

The rough, fiber-based structure of paper, however, is a limitation in the fabrication of devices using conventional lithographic techniques developed to fabricate devices on silicon wafers by the semiconductor industry. The use of graphite pencil lead traces, formed by the exfoliation of graphite platelets through the abrasion of the graphite lead while scribing on the paper substrate, allow electrically conductive pads to be patterned on the rough surface of paper.3,6,7 This simple approach has been used to demonstrate pencil-drawn-on-paper strain gauges, humidity, temperature, gas and chemical sensors.

In this project we aim to go beyond graphite to fabricate a plethora of electronic devices based on other van der Waals materials that share the same layered structure.

Methodology:

Figure 1 illustrates the proposed methodology to fabricate van der Waals based devices on paper.

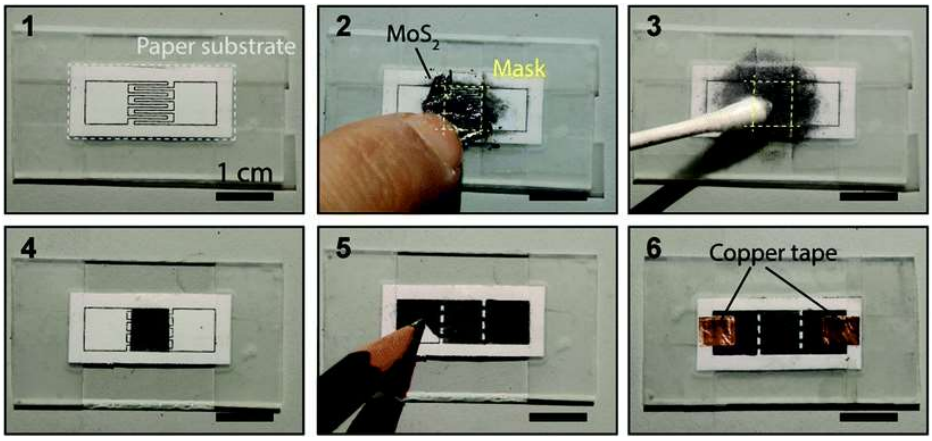

Fig. 1 Pictures of the fabrication process of a MoS_2-on-paper photodetector. (1) The outline of the interdigitated electrodes is printed out using an office laser printer and the paper is cut and fixed onto a glass slide with adhesive tape.

(2) A square mask is made in the device active area with adhesive tape and a MoS_2 crystal is rubbed against the bare paper area. (3) The drawn-MoS_2 is blurred with a cotton swab to improve the homogeneity. (4) After repeating the rubbing + blurring steps 4 times, the mask is removed yielding a very homogeneous MoS_2 square film. (5) The electrodes are drawn, following the printed outline, with a 4B pencil. (6) Two squares of copper tape are adhered to the graphite pads to allow soldering of the wires.