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Micro Four-Point Probe, Electrical Characterization of MoS_2

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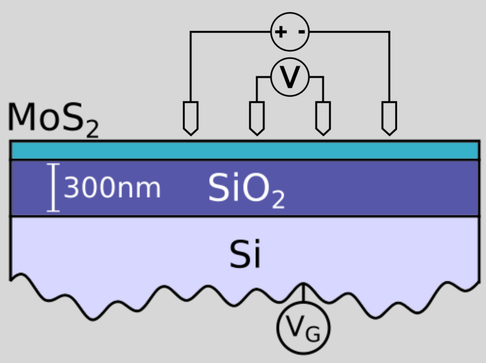
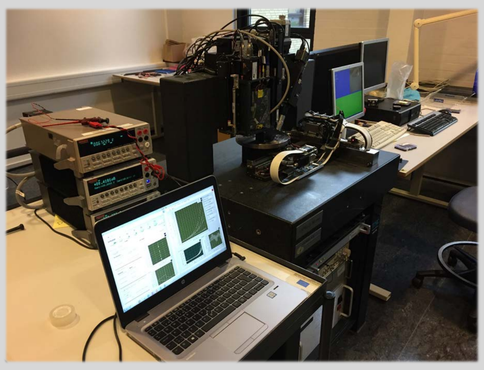
Abstract

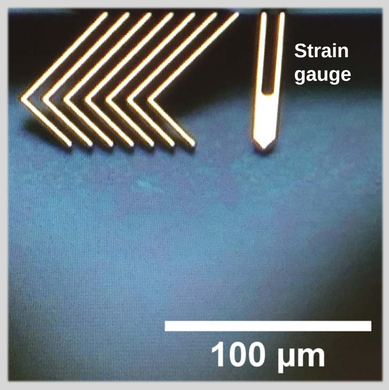
Here, we present the use of micro four-point probes (M4PP) to characterize 2D materials as an alternative or complementary method to using lithographically defined electrodes. Micro four-point probes allow the user to skip disrupting lithography steps and measure directly on the raw material. It also opens up for the possibility of doing uniformity studies that are not possible with a fixed structure characterization method.

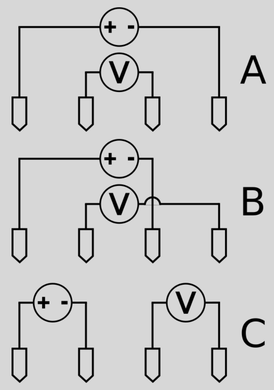
M4PP Field Effect Characterization

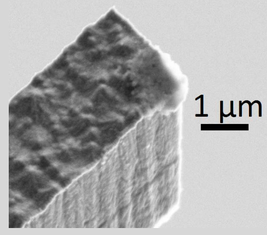




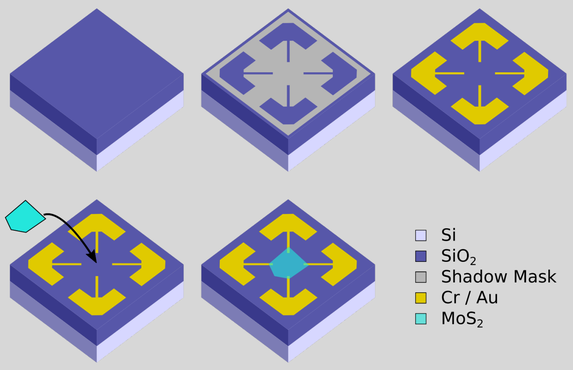
Micro four-point probes consist of four or more electrodes, connected to a movable probe, allowing for measurements to be performed anywhere on the sample. Measurements are performed by passing current through two electrodes, while measuring the potential drop across two others.

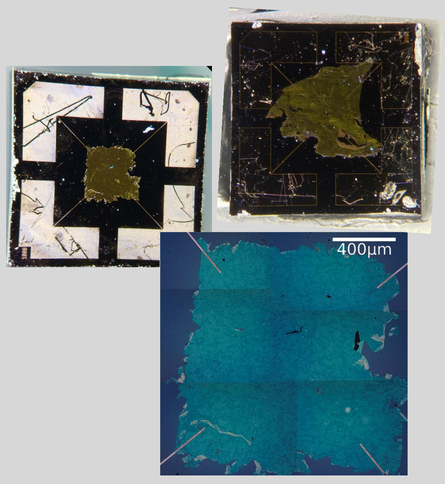






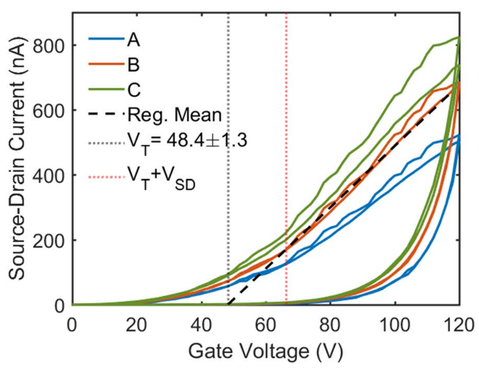
Sample

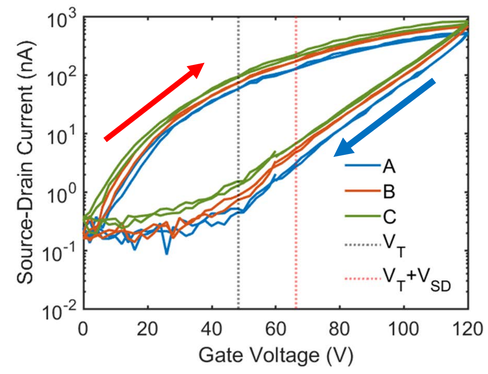




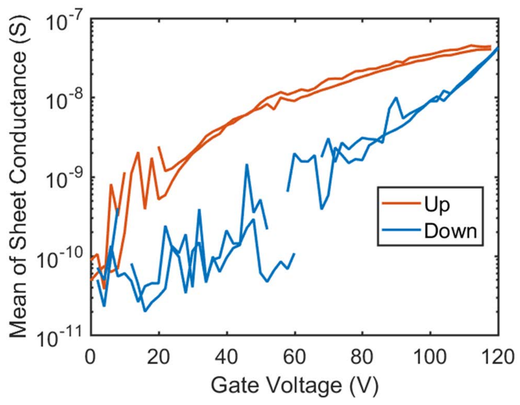
MoS_2 was grown in a CVD process [1] and then transferred to a substrate with electrodes (not used in these measurements) already lithographically defined.

Threshold Voltage





Sheet Conductance

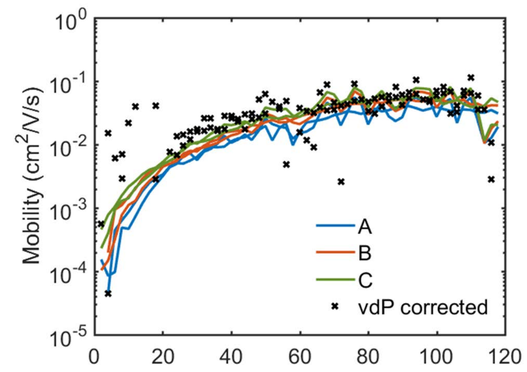


Van der Pauw corrected sheet conductance values.

$$e^{-\pi R_A/R_S} + e^{-\pi R_B/R_S} = 1$$

$$G_S = 1/R_S$$

Field Effect Mobility

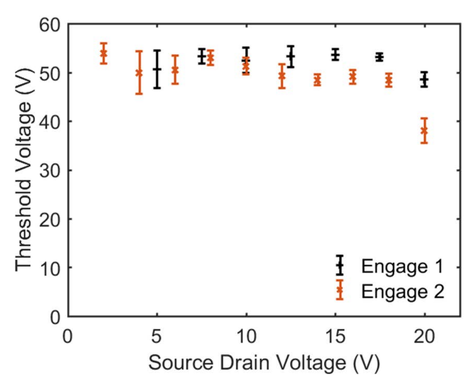


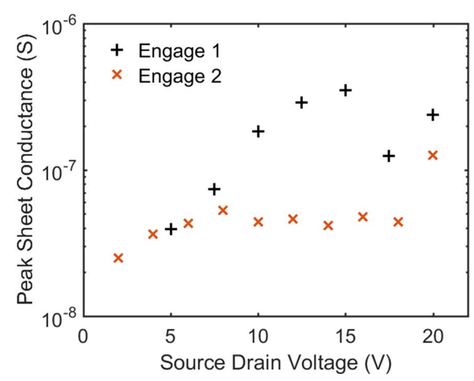
Field Effect Mobility, calculated based on 2p-measurements.

$$\mu_{FE} = \frac{dI_{SD}}{dV_G} \cdot \frac{1}{V_{SD} \cdot C_{ox}}$$

$$\mu_{FE} = \frac{dG_S}{dV_G} \cdot \frac{1}{C_{ox}}$$

Source-Drain Voltage Sweep





[1] A. Shivayogimath, et al., *A general approach for the synthesis of two-dimensional binary compounds*, https://arxiv.org/abs/1805.08002

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