

Van der Molen lab: Phase transition in 2D materials on gold

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Motivation

Van der Waals materials are layered crystals that allow to for exfoliation down to atomic thickness. The most famous example is graphite/graphene, however, there are many more! The main player in this project will be molybdenumdisulfide (MoS_2). This material shows the special property that different structural phases can occur: the semi-conducting 1H phase, the metallic and unstable 1T phase and the disordered and metallic 1T' phase (see figure 1). Control over these phases could enable the fabrication of functionalities (like a field-effect transistor) within one single layer of material.

The different phases can be induced by doping, strain and temperature. One of the ways to go from a 1H phase to the 1T' phase is by depositing a single layer of MoS_2 on a flat gold substrate and heating this stack. [1] The specific interactions between MoS_2 and gold, that cause this transition, are not well understood, and we would like to find out. In this project we will try to find out more about the 1H to 1T' transition by fabricating specific samples and investigating these samples in the Low Energy Electron Microscope (LEEM).

Project

You will first figure out how to make and design the optimal sample. First, a crystalline and very flat gold layer is needed. In the second stage you will deposit a mono-layer of MoS_2 on top of this gold layer. Finally we will study the phase transitions live in the LEEM by in-situ heating.

Your profile

You are interested in solid state physics. You like to be creative in the lab and are not afraid to try out new things. You have a practical mind set.

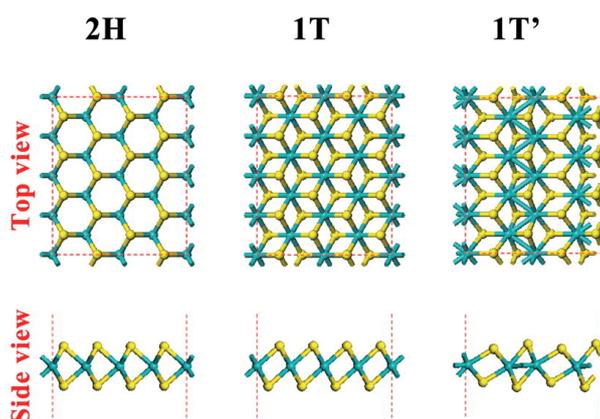


Figure 1: Different phases of MoS_2 : de 2H phase is a semi-conductor, the 1T and 1T' phases are metallic and can be induced by layering a very thin layer of MoS_2 on gold, and heating the stack. Figure from [2].

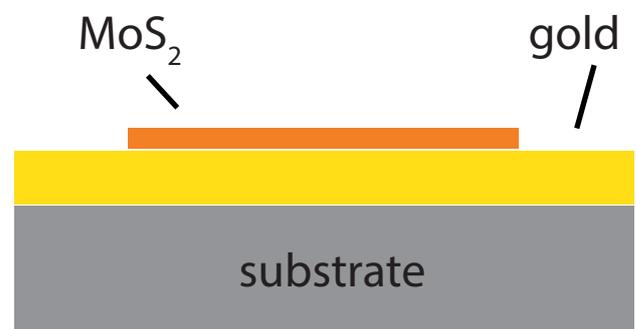


Figure 2: The proposed sample. First we need a thin crystalline gold film (yellow) on a substrate (gray), on top of the gold layer we put a monolayer MoS_2 (orange).

[1] Yin, et al. Nature Communications (2017)

[2] Gao, et al. The Journal of Physical Chemistry C (2015)