In situ studies of 2D materials growth and modification by low-energy electron microscopy and micro-diffraction

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Single sheets of layered materials often exhibit fascinating materials properties and hold great potential for applications in a wide range of technological areas. Whereas the traditional method for their preparation is exfoliation from bulk materials and transfer onto the support of choice, this approach is hardly scalable, calling for alternative ways to synthesize the different materials on selected substrates in a well-defined manner. Depending on the composition of the material and the nature of the substrate, this aim clearly poses a formidable challenge of increasing complexity for basic surface science.

Here, we will report on our recent efforts in the growth and modification of so-called two-dimensional (2D) materials on single crystal substrates. Using graphene/Ru(0001) and MoS_2/Au(111) as very popular examples, we will show how *in situ* low-energy electron microscopy (LEEM) and micro-diffraction (µLEED) can advantageously be employed to identify the most promising conditions that facilitate the controlled synthesis of well-ordered single layers. Furthermore, we will demonstrate that *in situ* characterization is essentially mandatory to unravel the underlying physics governing the relevant processes, e.g., the decoupling of the strongly bound graphene from the underlying support via intercalation as well as concomitant wrinkle formation. In the case of MoS_2 synthesis on the gold surface it will be shown that the growth kinetics largely determine the structure of the resulting film and that the substrate morphology is drastically changed upon growth owing to a relatively strong interaction between the film and the substrate. Moreover, we find a preferential orientation of the resulting MoS_2 layer when choosing conditions near the thermodynamic limit, similar to what we have also observed for the related WS_2/Au(111) system [1].

References

[1] L. Bignardi *et al.*, *Suppression of mirror domains in the growth of single-layer WS_2*, submitted.