Single-domain MoS_2: from single-layer growth to the formation of first bi-layer seeds

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Single-layer molybdenum disulfide (MoS_2) is a heavily investigated transition metal dichalcogenide owing to its direct band gap, rendering it very promising for novel optical applications. Consequently, the electronic properties of single-layer MoS_2 have been studied experimentally with several surface science methods. A well-known, prototypical model system is MoS_2 on Au(111). Here, we present real-time observations of MoS_2 growth on Au(111) at elevated temperature using in-situ low-energy electron microscopy (LEEM). Our continuous growth method leads to the formation of micron-sized single-layer MoS_2 islands. Employing two distinctly different deposition rates and carefully selected growth temperatures, we are able to tune the growth mechanism of the MoS_2 islands from a balanced distribution of the two expected mirror domains towards a single-domain distribution. The single-domain character of these islands is confirmed by dark-field imaging and micro-diffraction (µLEED), the former revealing a relative surface coverage of 90:10 of the mirror domains [1]. Intriguingly, selected-area angle-resolved photoelectron spectroscopy (µARPES) data of these mirror domains not only underline their three-fold symmetry, but also indicate the presence of MoS_2 bilayer regions. Using X-ray photoemission electron microscopy (XPEEM) and intensity-voltage (I(V)) LEEM, we identify the bilayer nucleation areas at nearly full surface coverage and propose a model pathway for their formation [2].

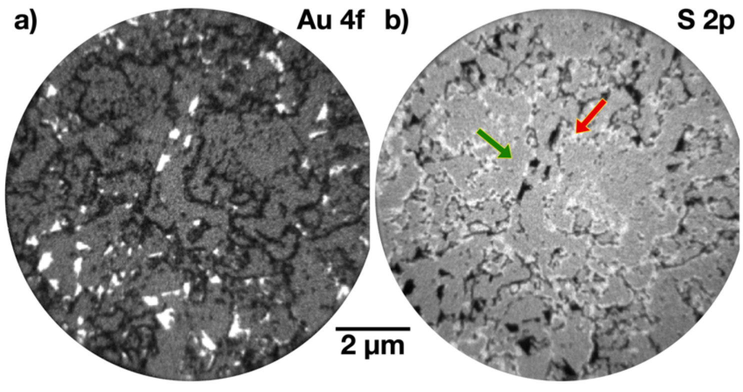

Figure 1. XPEEM data from Au4$f_{7/2}$ (a) and S2$p_{3/2}$ (b) core-level photoelectrons (hν ≈ 250 eV).

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References
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[2] M Ewert, L Buß, N Braud, AK Kundu, PM Sheverdyaeva, P Moras, F Genuzio, TO Menteş, A Locatelli, J Falta and JI Flege, *Front. Phys.* ***9****, 654845* (2021).