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Where the MoS_2 bilayer grows: An *in situ* LEEM study —
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Molybdenum disulfide (MoS_2) is well-known for changing from an indirect to a direct semiconductor when its thickness is reduced to a single layer, rendering a high degree of growth control a necessity for optoelectronic applications. An extensively investigated model system is MoS_2 on Au(111), which using molecular beam epitaxy typically grows as clusters. Here, we present an in-situ low-energy electron microscopy (LEEM) study of the extended growth of MoS_2 at 700°C and 750°C. These conditions lead to the formation of micron-sized single-layer MoS_2 islands. The single-domain character of these islands is demonstrated by employing dark-field imaging and micro-diffraction (LEED), which allow quantifying the relative coverage of the two mirror domains. Furthermore, selected area angle-resolved photoelectron spectroscopy of these domains directly confirms their threefold symmetric electronic bandstructure. Interestingly, under certain conditions subsequent structural characterization by I(V)-LEEM clearly identifies regions where a bilayer of MoS_2 has nucleated. Parameters influencing the bilayer growth as well as its electronic properties will be discussed.

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