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In-situ growth characterization of 2D heterostructures: $MoSe_2$ on intercalated graphene/Ru(0001) — •Lars Buss[1], Nicolas Braud[2], Moritz Ewert[1], Matteo Jugovac[4], Tevfik Onur Mentes[4], Andrea Locatelli[4], Jens Falta[2], and Jan Ingo Flege[1] — [1]Applied Physics and Semiconductor Spectroscopy, BTU Cottbus-Senftenberg, Cottbus, Germany — [2]Institute for Solid State Physics, University of Bremen, Bremen, Germany — [3]Elettra-Sincrotrone Trieste S.C.p.A, Bazovizza, Trieste, Italy

Despite the great fundamental interest in 2D heterostructures, most of the investigated 2D heterostructures were realized by mechanical exfoliation or chemical vapor deposition in the millibar range, preventing true in-situ characterization of the growth process. Here, we have investigated the growth of $MoSe_2$ on single-layer graphene on Ru(0001) via real-time in-situ low-energy electron microscopy and micro-diffraction. After preparation of the graphene by standard procedures from an ethylene precursor, $MoSe_2$ has been prepared via co-deposition of Mo and Se. Prior Se intercalation of the graphene appears to enhance the subsequent growth of $MoSe_2$ on the graphene. At elevated temperatures, rotational ordering of the $MoSe_2$ is facilitated by the strongly enhanced mobility of single-domain $MoSe_2$ islands that align with the high symmetry orientations of the underlying graphene, indicating a non-negligible interaction between the two van-der-Waals materials. Micro-spot angle-resolved photoemission proves the monolayer nature of the as-grown $MoSe_2$ as well as the free-standing character of the Se-intercalated graphene underneath.

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