ATOMIC-SCALE CRYSTALLIZATION AND RESTRUCTURING OF TWO-DIMENSIONAL MOS_2

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Atomically resolved and element-specific transmission electron microscopy (STEM) gave *in situ* insight in the crystallization and restructuring process of two-dimensional (2D) molybdenum disulphide (MoS_2) films (BAYER et al., 2018). Thin amorphous MoS_2 films on freestanding graphene membranes crystallized restructured from the energy input of the scanning electron beam into crystalline MoS_2 domains. This emulates widely used elevated MoS_2 synthesis and processing conditions.
From that direct observation of nucleation, growth, crystallization and restructuring events in the evolving MoS_2 films at the atomic scale was possible (Fig. 1). This suggests that during MoS_2 processing various MoS_2 polymorphs co-evolve and dynamically transform into each other in parallel. Transitions from in-plane to out-of-plane crystallization of MoS_2 layers indicate diffusion of Mo and S species and suggest that in this system and depending upon conditions crystallization can be influenced by weak MoS_2/graphene support epitaxy.
This atomic-scale *in situ* technique visualizes multiple fundamental processes that underlie the diverse MoS_2 morphologies observed in previous *ex situ* growth and processing work. It opens up an approach for studying growth and restructuring mechanisms of other 2D and probably virtually any layered materials.

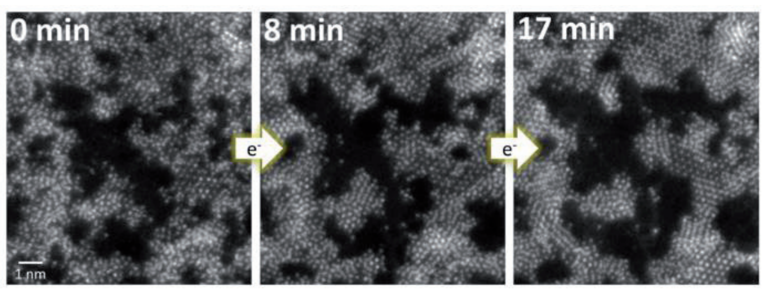

Figure 1. STEM image series of ~2 nm MoS_2 on graphene during continuous exposure to e-beam after 0, 8 and 17 minutes, which lead to crystallization from amorphous to nanocrystalline domains.

BAYER, B.C., KAINDL, R., MONAZAM, M.R.A., SUSI, T., KOTAKOSKI, J., GUPTA, T., EDER, D. WALDHAUSER, W., MEYER, J.C. (2018): ACS Nano, 12, 8758-8769.