Real-time tracking of the growth of small organic molecules on 2D-substrates by means of GI-SAXS/WAXS

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The shape anisotropy of small organic semiconducting molecules is responsible for the observation of a large number of different thin film polymorphs. Depending on the given application, either the standing-up or the lying-down molecular configuration is preferable. In this contribution, we will review the potential of 2D layers to control the molecular orientation in vacuum-deposited thin molecular films. In order to track the molecular orientation and thin film morphology we employed real-time GI-WAXS/SAXS techniques. As a basic example, we will introduce the growth of pentacene on monocrystal graphene [1]. Based on the GI-WAXS data we determined the unit cell of the lying-down pentacene phase and its orientation with respect to the graphene's unit cell. Moreover, using GI-SAXS we followed the Volmer-Weber growth of highly anisotropic pentacene islands. As another example, we will present the growth of diindenoperylene (DIP) on the few-layer MoS_2 films. The recent advances in CVD growth enabled fabrication of the few-layer MoS_2 films with their *c* crystallographic axis oriented parallel or perpendicular to the sample's surface normal (*n*). As a result, we observed the growth of the lying-down or standing-up DIP phases depending on the orientation of MoS_2 *c*-axis (Fig. 1). Technologically, this enables a controlled growth of various molecular phases on the same substrate being solely controlled by the local crystallographic orientation of the underlying 2D substrate.

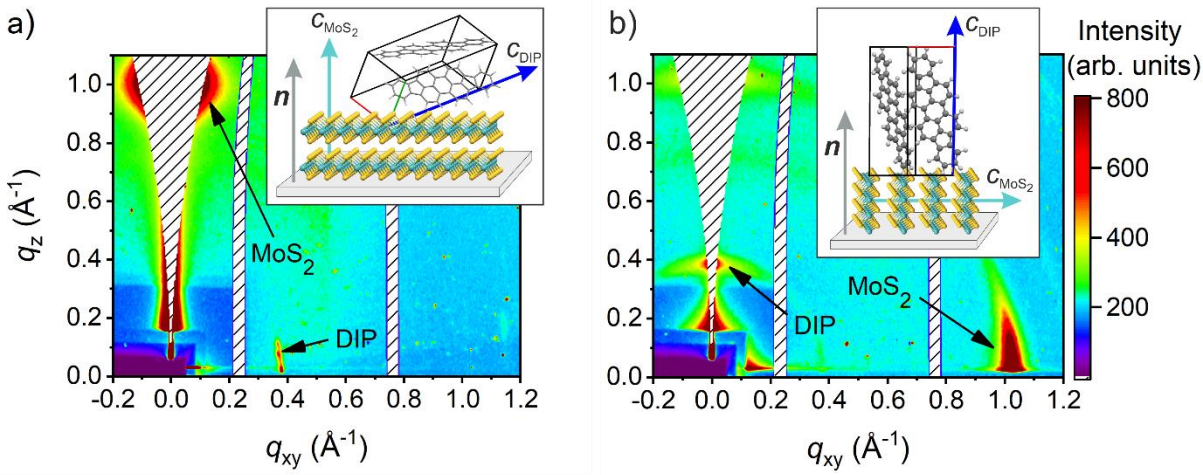

Figure 1: Reciprocal space map measured in the GIWAXS geometry for 12 nm thick DIP layer grown on a) 3 nm and b) 9 nm MoS_2 layer. Both patterns show 001 diffraction of DIP ($q \approx 0.39$ Å^{-1}) and 002 diffraction of MoS_2 ($q \approx 1$ Å^{-1}). The mutual orientation of the *c*-axes of DIP and MoS_2 is schematically shown in the insets.

References

[1] M. Hodas et al., ACS Appl. Nano Mater. **1**(6), 2819 (2018).