Layered, transition metal dichalcogenides (TMD), exhibit fascinating properties when the thickness is reduced to atomic size. For example, a transition from an indirect to a direct band gap can appear making them very attractive in electronics and optoelectronics [1]. The synthesis of high quality 2D TMD on large area is required to meet the microelectronics standards. For this purpose, we developed Se-based 2D TMDs (MoSe\(_2\), WSe\(_2\), PtSe\(_2\) etc.) grown by molecular beam epitaxy [2] on various substrates. Determining the crystalline orientations, strains, and grain sizes is of great importance to understand properties and to improve the growth. The in-plane grazing incidence x-rays diffraction technique [3] is well suited for the structural analysis of these layered materials on large surface. Our measurements were performed using a laboratory set-up equipped with a rotating anode (45kV @ 200mA). Two in-plane scans types were performed: i) reciprocal radial scans along directions of the substrate in order to determine in-plane lattice parameters, strains and domain sizes. ii) Azimuthal scans performed at Bragg angles found in the radial scans in order to investigate in-plane orientation and mosaic of the 2D layers with respect to the substrate. An example of such measurements is shown on the figures below for a multilayer WSe\(_2\)/PtSe\(_2\) grown on a Pt(111)/sapphire(0001). The results for the various TMD/substrates couples will be discussed, showing a large variety of epitaxial growths.

References


Figures

Figure 1: in-plane radial scans along <h00> and <hh0> sapphire substrate directions

Figure 2: in-plane azimuthal scans for various Bragg reflections of the substrate and of the over-layers