Imaging Ellipsometry with con-local Raman Spectroscopy on 2D Transition Metal Dichalcogenides with Different Layer Thicknesses

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2D transition metal dichalcogenides are atomically thin semiconductors of the type MX_2 with M representing the transition metal, in our case Mo or W, and X stands for the chalcogen, here Selenium. Due to the direct bandgap of $MoSe_2$ and WSe_2 these materials can be used in electronic and optoelectronic applications.

2D transition metal dichalcogenide layers were prepared by mechanical exfoliation. As a substrate we use Si wafer pieces with native oxide. The layer thickness ranges from monolayer to bulk.

Using an Accurion nanofilm_ep4 setup, we performed imaging ellipsometry. For the measurements we used two different objectives: 12.5 x with an operation range from 250 – 1700 nm and 50 x, which operates in the visible spectral range. An optical image of $MoSe_2$ flakes taken with the nanofilm_ep4 can be seen in Figure 1. Ψ- and Δ-maps of a $MoSe_2$ flake are shown in Figure 2, taken at a wavelength of 435 nm. By choosing different regions of interest (ROIs) we can investigate different parts with different thicknesses of the transition metal dichalcogenide.

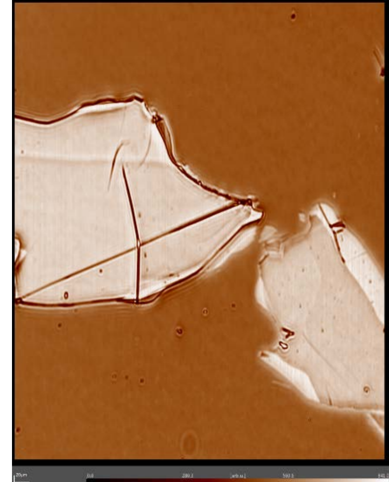

Figure 1 Optical image of $MoSe_2$ flakes with different thicknesses taken with the Accurion nanofilm_ep4

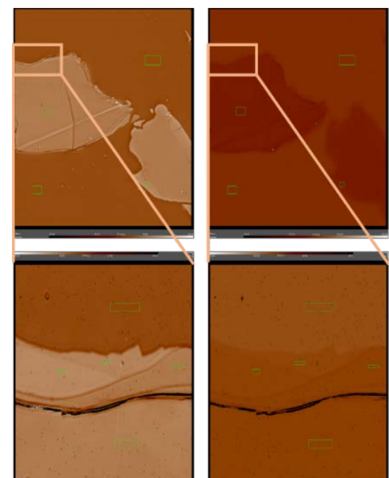

Figure 2 Ellipsometry maps of $MoSe_2$ flakes. The marked green areas show the ROIs: a) Ψ-map with 12.5 x objective, b) Δ-map with 12.5 x objective; c) Ψ-map map with 50 x objective, and c) Δ- map with 50 x objective taken at 435 nm.

Besides the optical properties obtained from the analysis of the ellipsometry spectra we also investigate the samples with Raman spectroscopy (532 nm). For this purpose a Horiba Raman head was mounted in the ellipsometer setup, so that ellipsometry and Raman spectroscopy can be measured con-locally.

We determine the dielectric function of the 2D transition metal dichalcogenide by using imaging ellipsometry with the thickness of the different flakes determined by modeling the data obtained and confirmed by the con-local Raman spectra.

Keywords: Imaging ellipsometry, spectroscopic ellipsomtry, 2D Transition Metal Dichalcogenides, Raman spectroscopy