Imaging Spectroscopic Ellipsometry and Spectral Reflectometry with Ellipsometric Contrast (SREC), Two Methods for Optical Characterization of 2D-Material

Peter H. Thiesen, Niklas Reineking, Dirk Hönig

Accurion GmbH, Stresemannstr. 30, Göttingen, Germany
pt@accurion.com

Abstract
Ellipsometry is a well-known non-destructive optical method for determining film thickness and optical properties. It measures the change in the state of polarization of the light reflected off the film's surface. Ellipsometry remains a macroanalysis technique, i.e., the sample size cannot be any smaller than about 20 µm. The development of imaging ellipsometry, which combines the power of ellipsometry with microscopy, has overcome this limitation. The enhanced spatial resolution of imaging ellipsometers in the range of 1 µm potentially expands ellipsometry into new areas of microanalysis, microelectronics, and especially exfoliated 2D materials.

In a number of papers, Imaging ellipsometry has been applied to characterize graphene flakes of few micrometer size. Ellipsometric contrast micrographs, delta and Psi maps as well as wavelength spectra [1],[2] and single layer steps in multilayer graphene/graphite stacks [3] have been reported. Also Molybdenum disulfide, a layered transition metal dichalcogenide have been reported [4]. As an example, Delta- and Psi maps of a MoS2 flake at different wavelength are displayed (figure 1).

Additional to microscopic characterization of tiny flakes, there is an increasing need of fast methods for quality control of large area graphene samples. This becomes possible by comparing the sample with a similar reference sample. Due to the orientation of the reference (see Fig. 1) it acts as an ideal compensator for all wavelengths. Hence no compensator is required. If the sample is equal to the reference, the outgoing light is linear polarized and can extinguished with a crossed analyzer. If there's any difference between sample and reference, the light becomes elliptic polarized and the detected light flux increases. In order to maximize the rate of data acquisition, the analyzer is set to an off-null-position. During the measurement neither the polarizer- nor the analyzer-angle are changed, so the measurement speed is only limited by the intensity of the light source and the processing speed of the spectrometer.

References
[1] Wurstbauer et al. (2010) Appl. Phys. Lett. **97**, 231901
[2] Matkovic et al. (2012) J. Appl. Phys. **112**, 123523 (2012)
[3] Albrektsen O. J. et al. (2012) Appl. Phys. **111**, 064305 (2012)
[4] Thiesen et al. (2014) AVS AVS 61st International Symposium and Exhibition on November 11-13, 2014, in Baltimore, Maryland (USA)

Figures

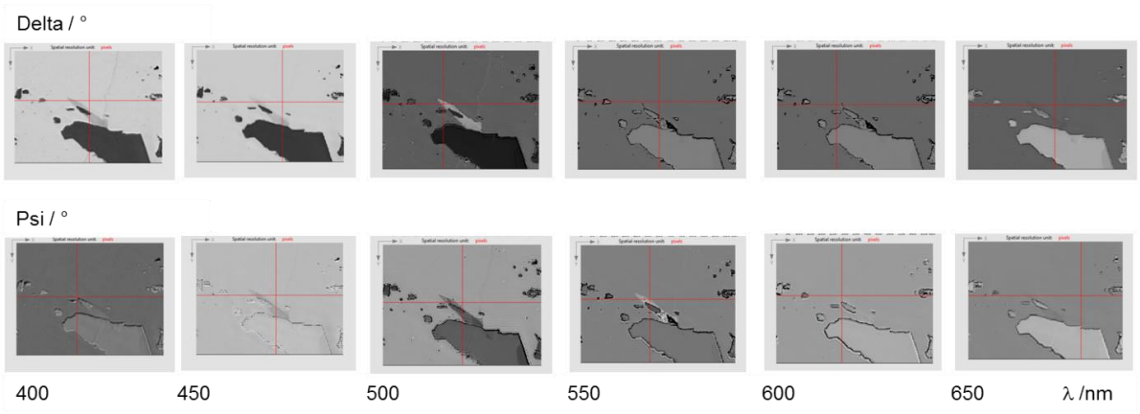

Figure 1. Delta- and Psi maps of a MoS2 flake at different wavelength.