application of imaging ellipsometry: localization and characterization of graphene crystallites

Introduction

Graphene consists of a sp²-hybridized atomic carbon crystal. Since it was first reported by Novoselov et al. (2004) it has been of increasing interest, because of unique physical properties and promising applications. Graphene samples are usually fabricated by micro mechanical cleavage of graphite.

Although graphene is produced nearly every time when a pencil is used, it is extremely difficult to find small graphene crystallites in between millions of thicker graphitic flakes. One method to make graphene visible in optical microscopy is based on air | SiO₂ | Si substrate with a optimized layer thickness. For other substrates, the localization is still an issue, requiring time consuming scanning techniques like Raman spectroscopy. The size of the up to date graphene flakes is in the 10 µm range what frequently is a limitation concerning optical characterization methods like classical ellipsometry.

For determination of the optical properties, graphene on the standard SiO₂ substrate is used due to the possibility for characterization of single graphene flakes.

Imaging ellipsometry

Ellipsometry is a sensitive optical method, which has been used for about a hundred years to derive information about surfaces. It makes use of the fact that the polarization state of light may change when the light beam is reflected from a surface. The elliptical state of polarization can be used for localization. The characterization of graphene oxide layers with imaging ellipsometry has been reported [Jung et al., 2008].

Ellipsometry is a sensitive optical method, which has been used for about a hundred years to derive information about surfaces. It makes use of the fact that the polarization state of light may change when the light beam is reflected from a surface. The elliptical state of polarization can be used for localization. The characterization of graphene oxide layers with imaging ellipsometry has been reported [Jung et al., 2008].

Ellipsometric contrast micrograph and Psi-ε-map of a graphene flake

Spectroscopic variable angle imaging ellipsometry

With an imaging ellipsometer, it is possible to measure small samples and it offers a very high optical contrast between thin layers that can be used for localization. The characterization of graphene oxide layers with imaging ellipsometry has been reported [Jung et al., 2008].

Localizing

The thickness of graphene is based on a dispersion function from database (nanofig_opa_model).

Modeling

The layer thickness of SiO₂, was calculated based on the dispersion functions from database (nanofig_opa_model).

Conclusion

Ellipsometric micrographs and Psi-maps are powerful tools for the visualisation and identification of graphene flakes. With an imaging ellipsometer, it is possible to measure wave-length spectra of Psi (ψ) and Delta (δ) of single graphene flakes. Promising is the discrimination of the optical properties with a Drude model.

References

