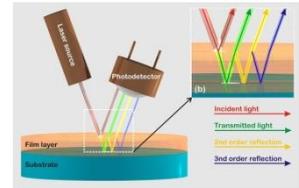


## ThetaMetrisis APPLICATION NOTE #027

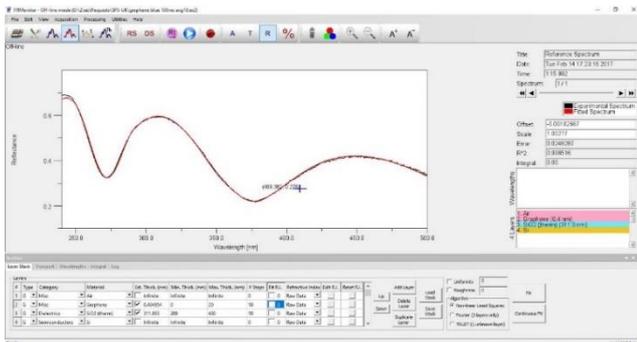
### Thickness measurement of mono-layered graphene on top of SiO<sub>2</sub>/Si wafer



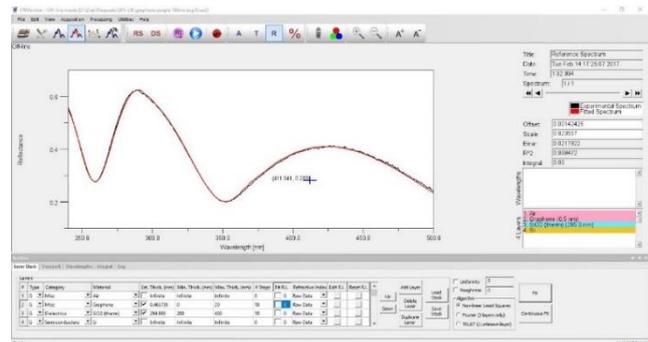
**Introduction:** Graphene (a single layer of graphite), is a unique material with great electronic properties. The unique structure and properties of graphene offer unprecedented opportunities and potentials in fundamental studies as well as in future nanoelectronics. In this application note, we measure the thickness of mono-layered graphene on top of SiO<sub>2</sub>/Si wafer, using FR-Tools.

**Means & Methods:** Samples for characterization were two mono-layered graphene films on top of SiO<sub>2</sub>/Si wafers (Sample A and Sample B), as shown in **Figures 1a,b**. Reflectance measurements performed using **ThetaMetrisis FR-Basic UV/VIS**, operating at the spectral range of 200-850nm.

**Results:** Typical experimental (black line) and fitted reflectance spectra (red line), as recorded on the FR-Monitor software, of both samples, are illustrated in **Figures 2a)** and **b)**, respectively. The fitting for both measurements applied in the 240-500 nm spectral range, and the thickness of graphene found to be 0.43nm and 0.46nm, and SiO<sub>2</sub>'s 311nm and 295nm, for sample A and B respectively.



**Figure 2a):** Specular Reflectance of **sample A** as recorded by FR-Basic. Thickness measured at 0.43 nm for graphene layer and at 311 nm for SiO<sub>2</sub> layer.



**Figure 2b):** Specular Reflectance of **sample B** as recorded by FR-Basic. Thickness measured at 0.46 nm for graphene layer and at 295 nm for SiO<sub>2</sub> layer.

In addition, both samples were characterized using a spectroscopic ellipsometer, and the results along with the ones from FR-Basic UV/VIS are illustrated on the following table.

| Sample | Layer            | Thickness (nm)  |                            |
|--------|------------------|-----------------|----------------------------|
|        |                  | FR-Basic UV/VIS | Spectroscopic Ellipsometry |
| A      | graphene         | 0.43            | 0.42                       |
|        | SiO <sub>2</sub> | 311.03          | 313.17                     |
| B      | graphene         | 0.46            | 0.51                       |
|        | SiO <sub>2</sub> | 294.98          | 297.64                     |

**Conclusions:** The capabilities of FR-Basic UV/VIS on thickness measurements of mono-layered graphene on top of SiO<sub>2</sub>/Si wafer were demonstrated. As can be observed, the fitting lines match perfectly on the reflectance spectra, indicating the usage of correct RI values for graphene and therefore an accurate measurement. The divergence between the measured values and graphene's theoretical monolayer thickness, which is 0.345nm (one atom thickness), could be attributed to the existence of an interfacial layer of air-water between the graphene and the SiO<sub>2</sub> and the thickness resolution of WLRS in such thin films.