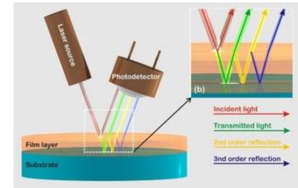
ThetaMetrisis APPLICATION NOTE #018

Thickness measurements of ultrathin (<5nm) SiO_2 films



Goal: The measurement of the thickness of thermally grown SiO_2 films on Si wafer.

Means & Methods: The samples were SiO_2 films thermally grown on 4inch Si wafer (SSP, prime quality). The Si wafers were cleaned in Piranha solution and then dry oxidized in a Tempress cleanroom furnace. The SiO_2 thickness as measured by a single wavelength ellipsometer was 4.6nm. Afterwards, two etching steps in HF were applied and the SiO_2 film thickness was measured by both single wavelength ellipsometry and an FR-Basic UV/VIS. The FR-Basic UV/VIS is equipped with a deuterium-halogen light source, a spectrometer operating in the 200-850nm spectral range with a 3648 pixels CCD, and a reflection probe of 200um core diameter.

Results: For the thickness measurements with FR-Basic UV/VIS the reference was a freshly cleaned from the native oxide 4inch Si wafer. The same reference was used for all measurements. The refractive index values used for the thickness measurement of SiO_2, were the ones that exist in the FR-Monitor database. The specular reflectance fitting was applied in the 230-800nm spectral range. The fitting results for the initial SiO_2 film (a) and the films resulted after each etching step (b and c) are illustrated below. In the table the thickness results are compared against the ones measured by the single wavelength ellipsometer.

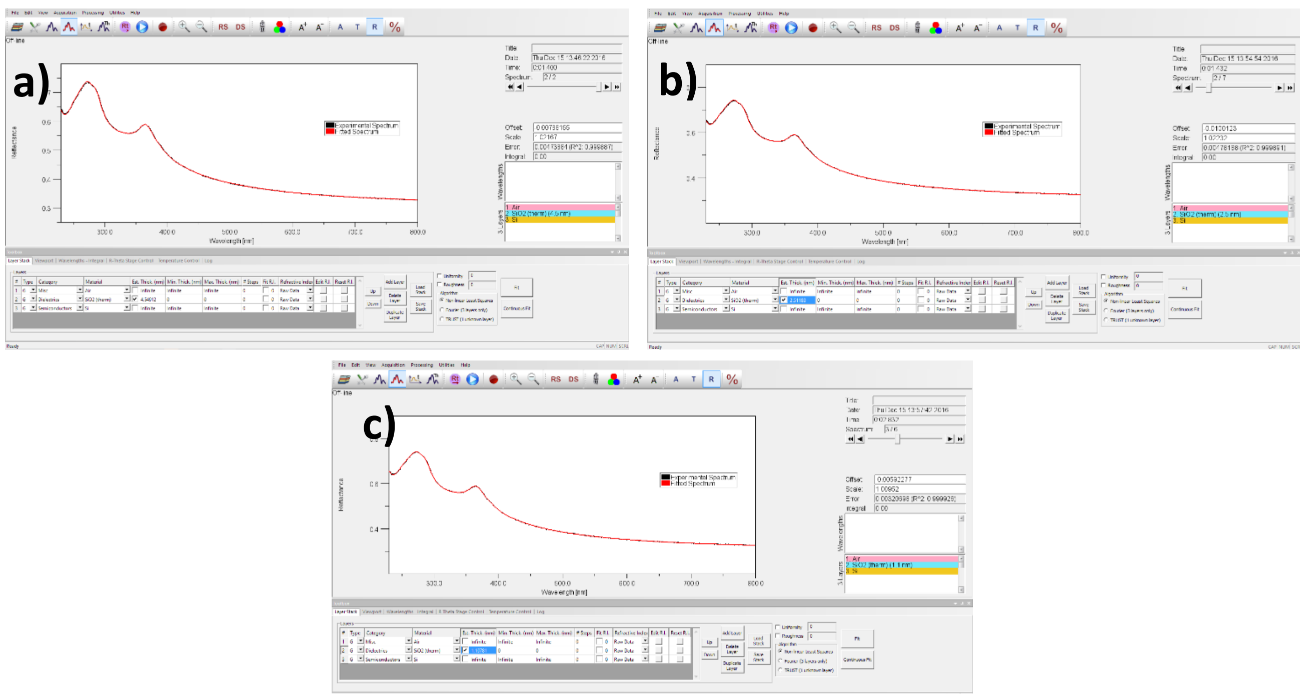


Figure 1: Specular reflectance measurements of ultra-thin SiO_2 films and the related fitting with the Levenberg-Marquart algorithm. The spectral range used for the fitting was 230-800nm.

	FR-Basic UV/VIS	Single wavelength ellipsometer
Sample 1 (SiO_2 after dry oxidation)	4.55nm	4.5nm
Sample 2 (after first etching step)	2.51nm	2.6nm
Sample-3 (after second etching step)	1.10nm	1.1nm

Conclusions: The thickness of thermally grown SiO_2 films was measured accurately with FR-Basic tools and the results were confirmed with independent ellipsometer measurements.

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