Infrared Müller Matrix Ellipsometry of Thin Films and Structured Surfaces

Andreas Furchner[a], C. Walder[a], M. Zellmeier[b], J. Rappich[b], and K. Hinrichs[a]

[a]Leibniz-Institut für Analytische Wissenschaften – ISAS – e.V, Schwarzschildstraße 8, 12489 Berlin, Germany
[b]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Institut für Silizium-Photovoltaik, Kekuléstraße 5, 12489 Berlin, Germany

Non-isotropic thin films can be characterized by their infrared Müller matrix (MM), which, besides anisotropy and structure, can provide information on film chemistry, composition, and molecular interactions. However, laboratory thin-film infrared MM measurements are inherently difficult, mainly because of low optical throughput, source prepolarization, and non-ideal polarizers.

We developed a novel IR Müller ellipsometer with high optical throughput that enables sensitive MM measurements of thin films below 100 nm. The measurement scheme can be restricted to a subset of defined polarizer settings, allowing one to extract quadruples of Müller matrix elements within a few 10 seconds to minutes. Tandem polarizers gurantee a sufficiently high degree of polarization necessary to accurately measure block-offdiagonal MM elements.

We demonstate MM measurements of thin polymer films and structured surfaces (trapezoidal SiO_2 gratings), the offdiagonal MM elements of which are highly sensitive towards structure and orientation, as verified by RCWA calculations.

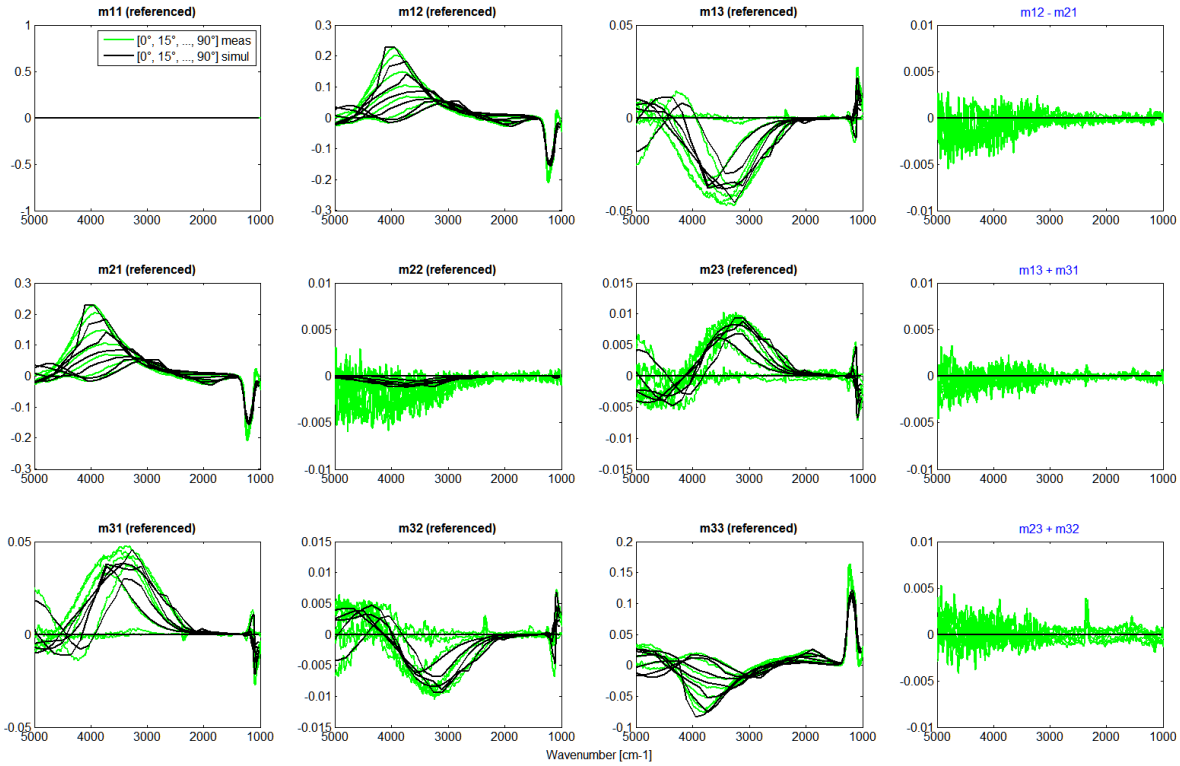

Fig. 1. Azimuth-dependent Müller matrix (measured vs. simulated) of a trapezoidal SiO_2 grating on Si.

Keywords: Infrared Mueller matrix ellipsometry; SiO_2 gratings; Thin films