Development of a multiangular broadband scatterometer for critical dimension metrology at EUV wavelength

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The semiconductor technology roadmap shows that the structure dimensions in the semiconductor industry in will be decreased to 10 nm or less within the next years. Hence, there is a strong demand for a metrology method that is sensitive and accurate in this range of structure sizes. Optical scatterometry is a preferable solution for this challenge, but previous studies have not demonstrated a sufficient sensitivity to variation of geometrical parameters of nanogratings using visible and UV wavelengths.

Our simulation results demonstrate that spectroscopic reflectometry in shorter wavelengths range (EUV, 5 nm to 40 nm) shows reasonable sensitivity to geometrical parameters variation (Fig 1). The simulations also demonstrate that considering higher diffraction orders (±1st orders) lead to increased sensitivity even for sub-10 nm nodes.

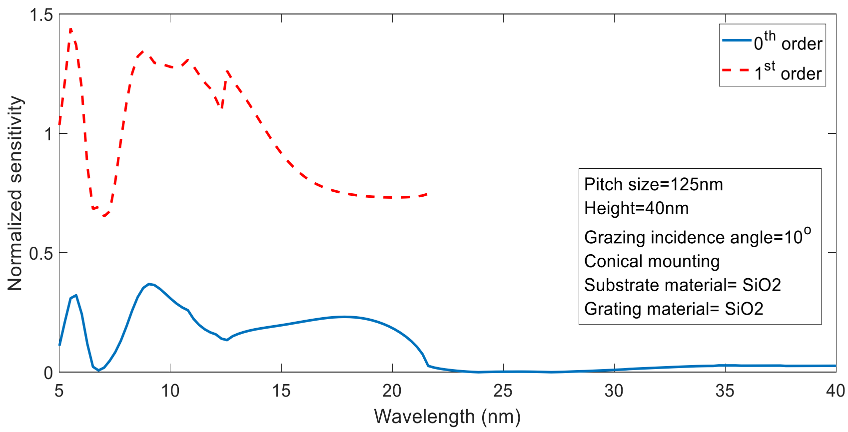

Fig. 1 *Simulated normalized sensitivity of diffraction efficiency to a critical dimension variation from 7 nm to 7.5 nm for 0th and 1st diffraction order of a rectangular grating measured in conical mounting.*

In order to experimentally investigate the scattering behavior of periodic nanostructured samples a multiangular broadband scatterometer is designed. The design of the scatterometer setup is based on a table-top EUV reflectometer utilizing a compact gas discharge-produced plasma EUV source. This setup is capable to measure spectrally resolved 0th and 1st orders diffraction efficiency under grazing incidence illumination in the EUV wavelength range (9 nm to 17 nm).

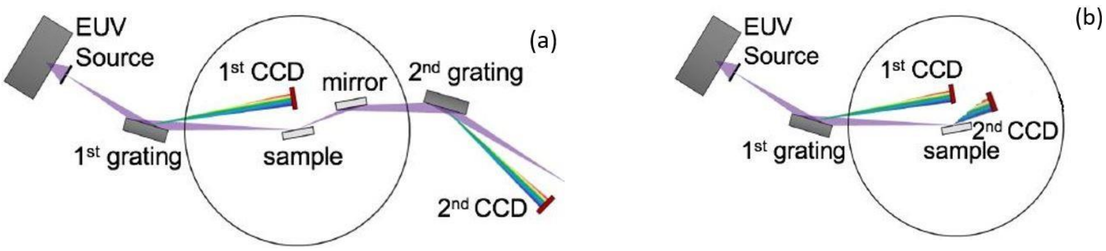

Fig. 2 *Scheme of the scatterometer setup in 0th order (a) and 1st order (b) measurement modes.*

The comprehensive parameter study reveals that employment of grazing incidence angles and use of conical mounting of the grating helps to achieve the highest accuracy in reconstruction of geometrical parameters. Confirming these findings experimentally will pave a way towards practical applications of the suggested metrology method, both in science and industry.