Defect Inspection on Masks for EUV (13.5 nm) Lithography Using “Standing-Wave PEEM”

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Extreme Ultraviolet Lithography (EUVL) at 13.5 nm photon wavelength is the most promising candidate for next-generation lithography beyond the 32 nm node. However, the fabrication of defect-free EUVL masks and mask blanks including their inspection is a tremendous challenge for the successful implementation of EUVL. Fast inspection techniques that ensure detection of nanosized defects in the multilayer reflective coatings of the mask blanks (usually Mo/Si multilayers tailored for high reflectivities at 13.5 nm) are crucial for a reliable supply of defect-free lithography masks.

Full field PEEM employing standing-wave illumination of the mask sample, is a promising *at wavelength tool* for fast screening of mask blank defects because it detects any deviation from the interference pattern of the photon field at the surface [1]. We have demonstrated its sensitivity to phase defects with lateral sizes down to 50 nm in a programmed mask blank sample [2,3], a typical standing-wave PEEM image is shown in Fig. 1 (left panel). The observed contrast variation at different inspection wavelengths is in agreement with the simulation results of a standing wave field on the surface of the multilayer stack in the mask blank (right panel). When the wavelength is chosen such that a node appears at the surface, defects appear bright because they lift the destructive interference condition present in regions with intact multilayer.

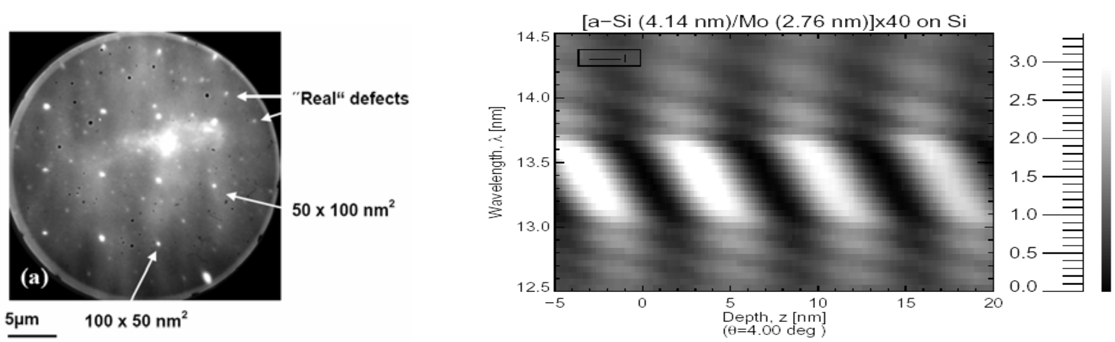

***Fig.1**: EUV-PEEM image at 13 nm photon wavelength of Mo/Si multilayer test sample with programmed and real defects (left). Calculated electric field contours vs wavelength and depth (z=0: surface) into the film at 4° off- normal incidence (right). Brightness scale normalized to intensity of incoming wave (=1.0).*

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[1] G. Schönhense and U. Kleineberg, German patent DE 100 32 979 A1 (2002)
[2] U. Neuhäusler et al., *Appl. Phys. Lett.* **88** (2006) 053113
[3] J. Lin et al., submitted for publication