EUVL Aberration Metrology using Resist Images from a Strong Phase Shifting Mask

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As is true for optical nanolithography, a significant source of image degradation in EUVL lithography systems is optical wavefront aberration. As the resolution of these systems increases, the effect of wavefront aberration on aerial image performance becomes much greater. The tolerance of such aberrations is governed by the requirements of features that are being imaged, requiring lenses that can be corrected with a high degree of accuracy and precision. Additional concerns for wavefront performance with EUVL systems arise from such things as short-term and long-term heating, contamination, and degradation issues. The need for highly accurate, in-situ, process compatible measurement and correction of aberrations in EUVL systems is therefore paramount.

Resist based aberration metrology can take on many forms such as a Shack-Hartman method based on pupil sampling, phase artifact approaches of mapping the objective lens pupil, or approaches of fitting image data by iterating the pupil wavefront description. In our approach, both structures printed using a binary mask and an 180 degree alternating EUV phase shifting mask (PSM) are used to produce corresponding photoresist images through EUV exposure. Phase shifting targets, including phase wheels (Smith 2006), phase disk (Dirksen et al. 2000) and three bar structures are investigated to increase the accuracy of the extracted aberration data. These targets are imaged on the LBNL MET and AIT tools using specific illumination settings to enhance the sensitivity of printed images to lens aberrations. In this paper we will present results from our experiments using these phase shifting masks. We will also report on our attempt to combine these experimental results with dense lithography simulations to determine corresponding pupil aberration levels. Figure 1 shows (a) an image of a phase wheel reticle (4x) measured on the Actinic Inspection Tool at Berkeley, which is sensitive to wavefront distortion and (b) a SEM micrograph of a phase wheel printed in photoresist on the MET in LBNL.

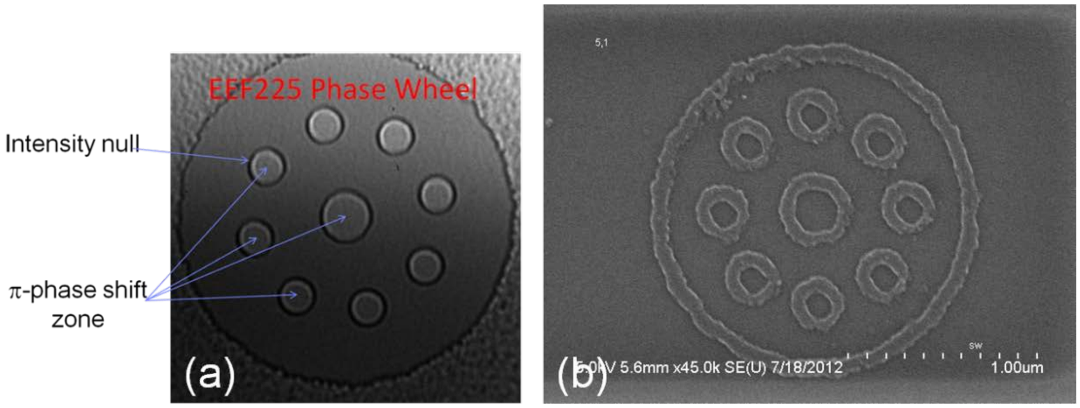

Figure1: (a) Actinic image of a phase wheel target on the pi phase shift reticle, *(b)* SEM micrograph of photoresist image of pi phase edge.