5. Adaptive-Membrane-Mask Technology

Sponsors:
Unfunded

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One factor limiting the area of patterns produced by conventional mask-based lithographic systems is the distortion present either in the mask, the substrate, or the optics of the lithographic system. The traditional approach to dealing with such distortion is to create the patterns on rigid masks, and build complex and expensive optical systems that minimize their inherent distortion.

We are investigating an alternative approach to the problem of distortion, which we call the Adaptive Membrane Mask (AMM) scheme. In this approach, the pattern is defined in an absorbing material on a thin, flexible membrane mask, typically made of Silicon Nitride or Silicon Carbide between 1 and 2 microns thick, similar to the masks used in x-ray lithography (XRL). Rather than trying to prevent distortion in the mask, we seek to use and control the flexibility of the mask to our advantage, with the goal of getting a better result than would be possible with even a perfectly rigid mask. In this way, our approach is akin to adaptive optics, where the shapes of flexible optical elements are controlled to correct for atmospheric turbulence. With AMM, mask distortion is controlled by introducing a temperature distribution across the mask to create thermal stresses that compensate for measured distortions in the mask, the substrate and the optics. This approach is shown schematically in Figure 1. Preliminary experimental work has been performed, which correlated well with numerical models.

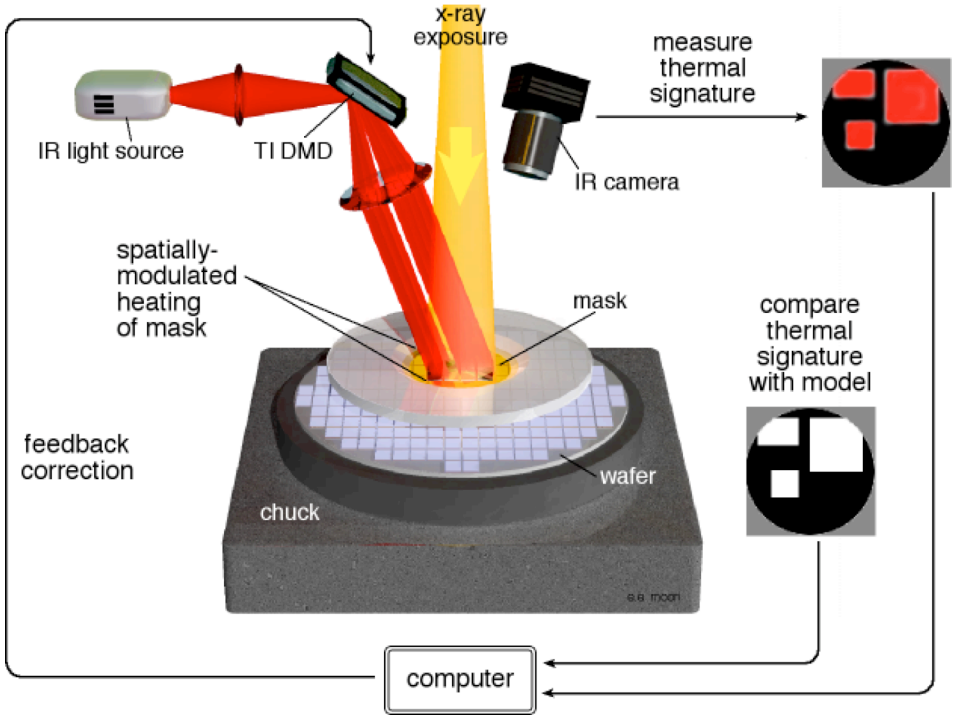

Figure 1. Proposed implementation of Adaptive-Membrane-Mask distortion correction applied to x-ray lithography. The basic scheme is applicable to most mask-based lithographies.