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EUV Focus Sensor: Design and Modeling

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We describe the design, modeling, and fabrication of a prototype EUV focus sensor (FS) designed for use with 0.3-NA EUV projection-lithography tools. At 0.3-NA and 13.5-nm wavelength, the depth of focus shrinks to 150 nm increasing the importance of high-sensitivity focal-plane detection tools. The FS is a free-standing Ni grating structure that works in concert with a simple mask pattern of regular lines and spaces at constant pitch in one direction. The FS pitch matches that of the aerial-image intensity. It transmits the light with high efficiency when the grating is aligned with the aerial image laterally and longitudinally. As the grating structure is scanned in two dimensions (x and z), the changing light throughput, measured with a single-element photodetector, quickly reveals the optimal wafer (focus) position.

The system design balances the opposing needs of high sensitivity and high throughput. For a given fixed pitch of 80 nm in the image plane, the primary design parameters for the system under consideration in this paper are the absorber membrane thickness and the open width of the grating apertures. With aperture widths on the order of 2–3 wavelengths, and aspect ratios of 2–4, modeling requires vector electromagnetic-field calculations. We are using TEMPEST 3D, a time-domain, vector electromagnetic field simulation program, to optimize the FS design. The characteristics of the mask illumination are included in the calculations in order to model the effects of unpolarized, partially-coherent illumination conditions. The annular illumination profile of the Micro-Exposure Tools (MET) are used as the basis for this study.

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Key Words: Extreme ultraviolet lithography, focus sensor, aerial image monitor

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