Development of a Full-Field Inteference Lithogrpahy System Based on a Long-Coherence-Length Laser Source

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Interference-assisted lithography is an immerging lithography concept, combining high-pitch grating patterns with relatively low-density, low-resolution trim and stitch steps, which offers the possibility of producing IC devices with leading-edge performance at substantially reduced cost. The grating patterns can be made by imaging a grating mask, however there are also several possible maskless approaches based on projecting interference patterns. One approach is to use the available UV lasers, with low spatial and temporal coherence lengths, to create small-field interference patterns, which could be raster scanned or stitched to make full die field grating patterns. Somewhat larger interference patterns can be obtained with these systems using achromatic grating-beam-splitter interferometer designs. An alternate approach would be to use a UV laser with high mode quality and high spatial- and temporal-coherence properties to generate a large-area interference pattern with a single illumination, but such a laser system has not been available for wavelengths below 200 nm with high power. We discuss our development of an immersion interference lithography exposure tool, based on a unique new 197 nm solid state laser system, that should enable high-contrast interference pattern exposures over a full die field at commercially viable powers. The long-coherence-length approach has a number of desirable properties and a number of challenges that will be discussed. We will present full-ray trace models of our system design, and model its performance. A major difficulty with interferometric-based patterns for lithography is controlling the fringe pitch, curvature, orientation, and position sufficiently to satisfy the overlay tolerances, ~2 nm. We discuss our approach to satisfying these challenges using feedback metrology based on nulling moiré patterns on a reference grating, and feeding back to the fine-frequency control of the laser source, to adaptive optics used to correct field curvature, and to stage positioners.