High-current electron optical design for REBL direct write lithography

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We will present the latest design and results for the 2nd generation column used in the REBL (Reflective Electron Beam Lithography) program. The previous magnetic prism based concept has been replaced with a new concept used to separate the illumination and projection beams which allows the column to be shrunk in size by a factor of 3, resulting in reduced coulomb blur and energy spread. Blur vs. current measurements from the column will be compared to simulation and show a significant improvement over the previous design. The figure shows a projected image from the new column in which 24 nm lines and spaces are beginning to be resolved.

Optimization of the optical design for REBL involves a number of tradeoffs, some of which are unique to the reflective design. In particular, telecentricity of both the illumination beam as well as the projection beam is key to proper performance. The numerical aperture of the illumination and the acceptance aperture of the projection need to be matched to the characteristics of the reflection from the DPG (Digital Pattern Generator) chip. The DPG chip is fabricated with microlenslets and their performance must be included in the overall design. Increasing the energy above 50 keV would provide significant performance advantages, even after taking into account the loss in resist sensitivity. Simulations indicate that further improvements in the design will allow currents capable of multiple wafers per hour and blur < 30nm.

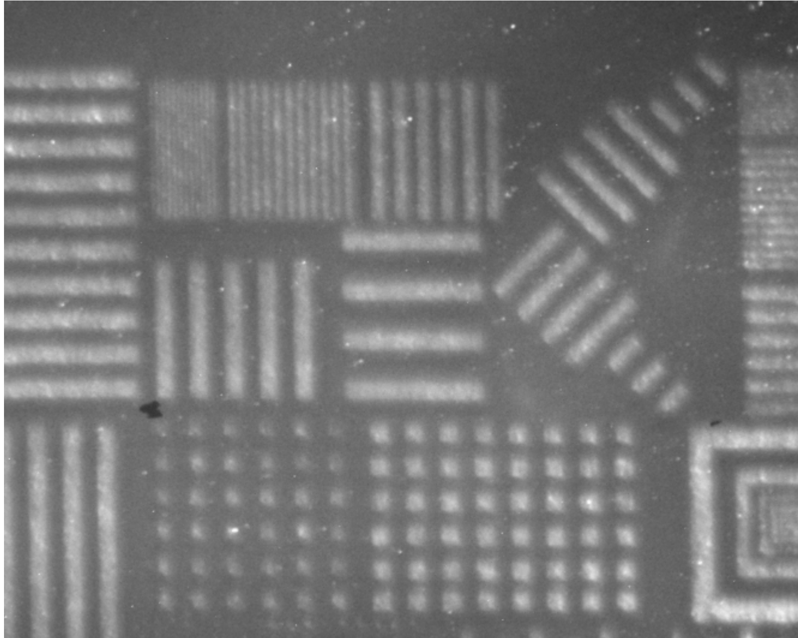

Figure 1: Wafer plane image from the 2nd generation REBL column projected onto a scintillating screen. The image is formed by reflection off a fixed pattern DPG chip. The smallest features are 24 nm lines and spaces (measured at the wafer plane).