Image distortion in REBL system: the correctable and the residual

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The Reflective Electron Beam Lithography (REBL) system is a maskless direct-write lithography technology being developed as a potential alternative to optical lithography technologies. REBL could be a viable option to extend semiconductor manufacturing to the 16 nm half pitch technology node and beyond. REBL uses a novel multi-column wafer writing system combined with advanced stage architecture to enable the throughput and resolution required for a NGL system. Using a CMOS Digital Pattern Generator chip (DPG) with over one million microlenses, the system is capable of maskless printing of arbitrary patterns with pixel redundancy and pixel-by-pixel grayscaling at the wafer.

This paper examines the details of image distortion caused by the electron optical lenses as the image traverses through the latest generation of the REBL electron-optical column. The magnitude and the source of distortion have been identified and the impact on the feature placement and blur is discussed. Depending on the choice of data path the distortion can show up as blur which would RSS into the optical blur or emerge as a shift which could cause a positional error. Strategies have been developed to reduce optical distortion and the magnitude of residual distortion is small enough that it can be corrected in the data path by pre-distorting few pixels as the data traverses through the digital pattern generator (DPG). Theoretical calculations on distortion are validated by experimental results. The effects of dynamic coils on distortion are presented.

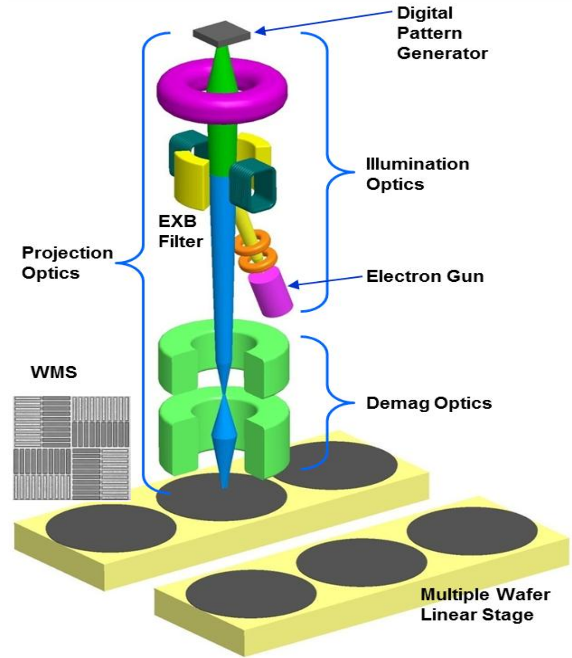

Figure 1: Schematic of the latest generation of REBL column showing the illumination optics, DPG, projection optics and the linear stage.

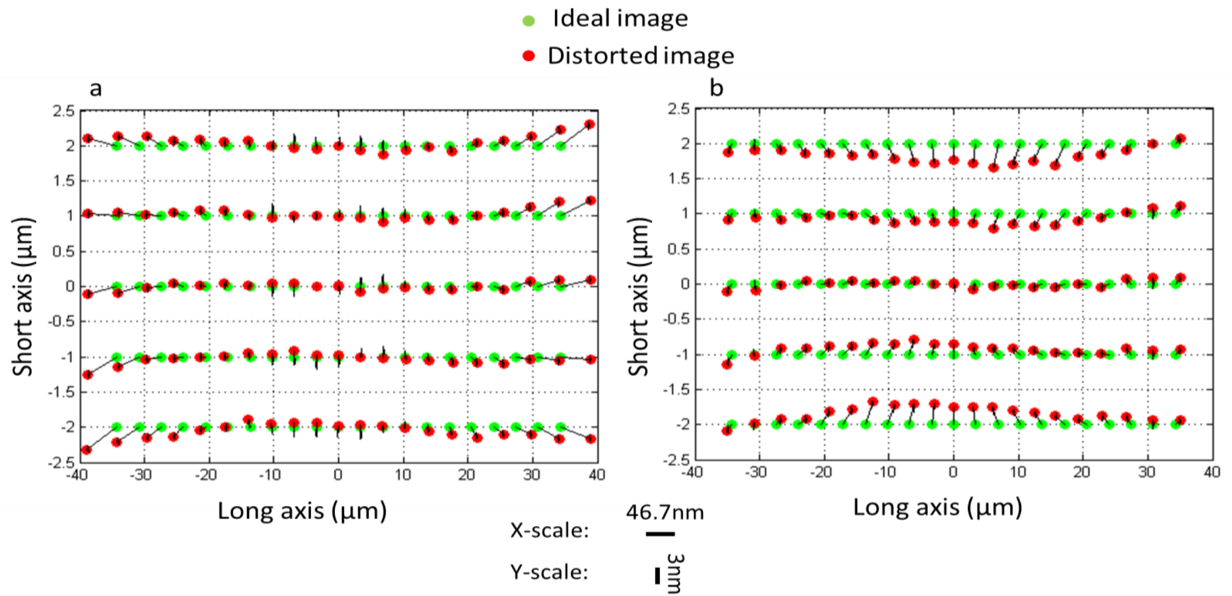

Figure 2: a) Ideal and distorted imaged of DPG at wafer plane before correction. b) Ideal and distorted image of DPG at wafer plane after isotropic magnification correction. The residual distortion is small enough and can be corrected in the data path.