Statistical Comparison of Field Distortion Correction by Z-Stage Movement vs Height-Correction Hardware in a Modern EBL Tool

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Modern electron-beam lithography tools are expected to operate within very tight specifications, in order to meet lithographic requirements for today's and tomorrow's cutting-edge electronic and photonic device fabrication. Specifications for linewidth fidelity, field stitching, and absolute feature placement accuracy demand the highest levels of performance. In this work, the performance of the hardware height compensation mechanism in a modern Gaussian-beam, vector-scan lithography tool is statistically compared with use of the Z stage to correct for height on a field-by-field basis, in order to determine the method most likely to yield the best writing performance on a non-flat substrate.

A test sample is prepared by writing an array of square marks on a 4" Si wafer. Four marks per field are written, using the four corners of the writing field. After development, the wafer is coated with metal and the resulting marker array is formed via lift-off. The test wafer is then re-loaded into the lithography tool. For each writing field, the positions of each of the four marks is found, with respect to the center of the field. The fields are visited in a spiral-out order, beginning near the center of the wafer.

Location of the marks can be performed under several conditions:

- Fixed Z position, no height compensation
- Fixed Z position, height compensation active
- Z position adjusted to bring the substrate to reference height before locating marks in each field, therefore no height compensation required

Subsequent statistical and graphical analysis of the collected data provides insight into the dynamics of the tool's height correction capabilities, and helps to inform the choice of Z drive motion vs height correction. In addition, should anomalies be observed, the analysis provides useful diagnostic information.

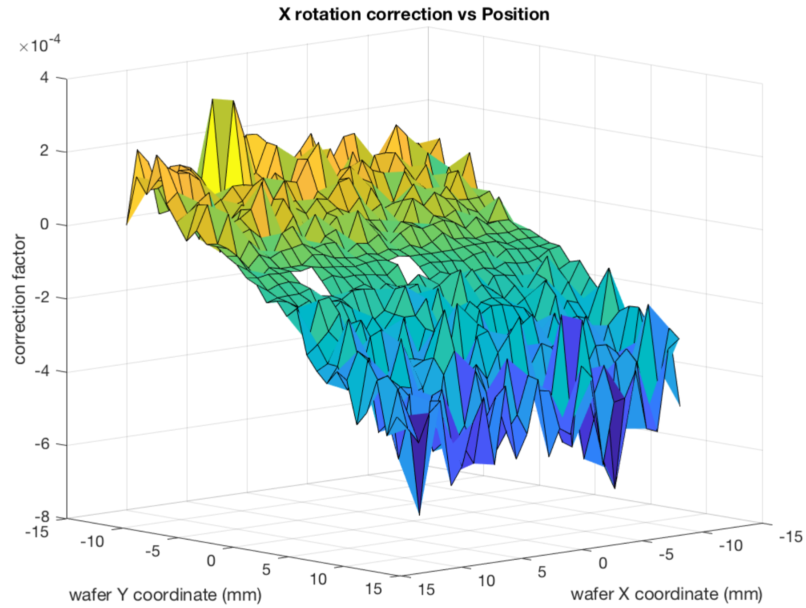

Figure 1: Y Rotation correction vs X-Y Position: Calculated rotation correction, *without height correction*, in the X direction, vs position on the wafer. 781 fields measured; marker spacing 450 µm; field size 520 µm.

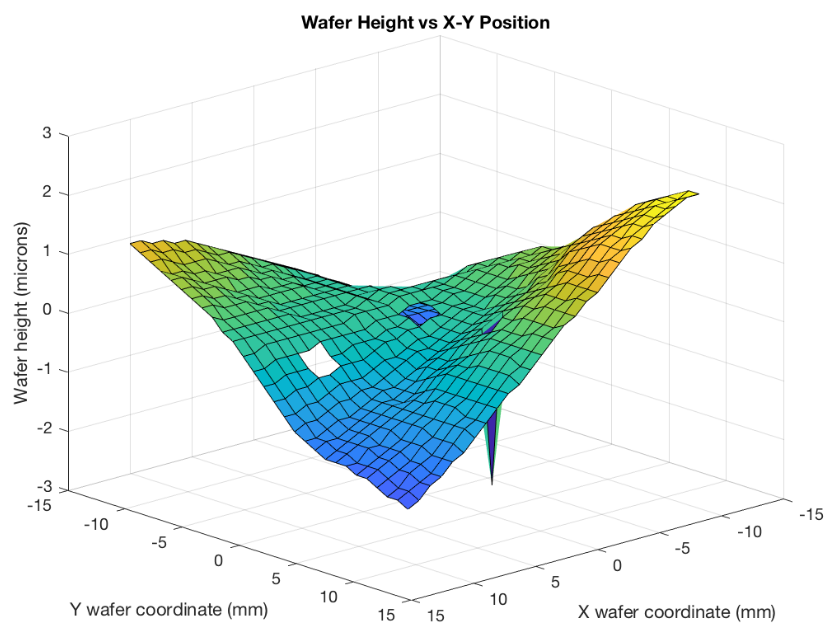

Figure 2: Wafer Height vs X-Y Position: Measured wafer height vs X-Y position on the wafer. 781 fields measured; measurement spacing 900 µm.