Measuring the Patterning Precision of Large Area Advanced Lithography with Interferometric Measurements

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Subnanometer placement precision over large areas (~100's cm^2) is highly desirable for many lithographic applications. Assessing whether these requirements are met, however, becomes increasingly complicated as patterning area increases and feature size decreases. Common metrology techniques are either only valid over small areas (micron-scale), prohibitively time consuming, or even destructive (such as use of scanning electron microscopes on resist). Over large areas, systematic issues such as EBL stitching error can become dominant in total error budget but are hard to quantify. We adapt a classic technique from diffractive optics which, when applied to lithographic patterning, allows researchers to **assess the characteristic errors of patterns produced via lithography over large-areas non-destructively.** Samples are measured interferometrically in back-diffraction as is shown in Figure 1[1].

This presentation is an outgrowth of our efforts to integrate electron-beam lithography and nanoimprint lithography into a complete, tunable process for fabricating astronomical gratings. From these measurements, fabricators are able to assess the quality of pattern fracturing, ordering, and total stitch error which informs process development and overall success of technique. Though demonstrated for EBL, this method is adaptable to a broad variety of applications, including patterning on curved substrates.

[1]DeRoo, C. T. et al. 2020, "Limiting spectral resolution of a reflection grating made via electron-beam lithography," The Astrophysical Journal, 905(1), 2020 https://doi.org/10.3847/1538-4357/abbe15

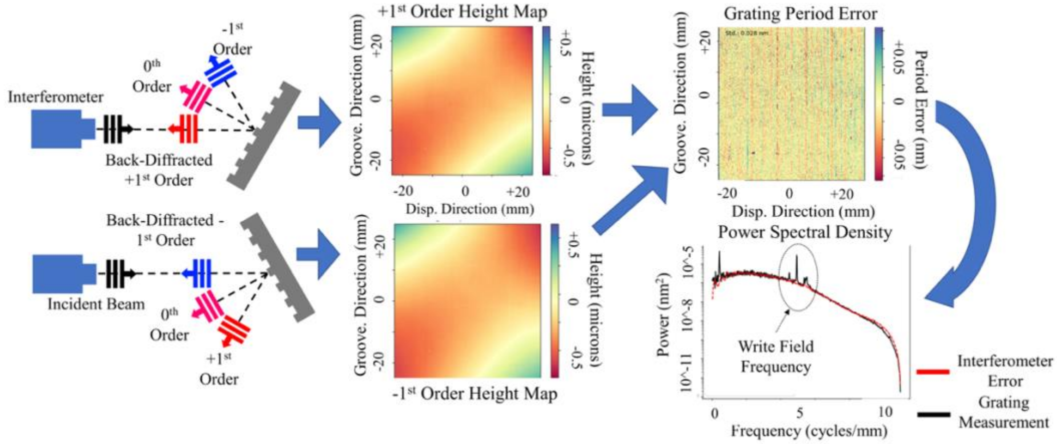

Figure 1. **Interferometry is a powerful tool for assessing the sources of limiting errors and the capabilities of a grating**. (Left) Constant-period grating placed at the back-diffraction angle relative to the incident plane wave produced by the interferometer. (Middle) Height maps as measured by the UI AccuFizH100S. (Top Right) A map of the groove period error over the grating is calculated from the two interferograms. (Bottom Right) The power spectrum of the groove period error allows for a frequency analysis to assess the impact of stitching. Black is the power spectrum of the measured grating period error, red is the power spectrum of the noise. Figure from *DeRoo 2020*[1]

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