Scatterometry of a 50-nm Half Pitch Wire Grid Polarizer

Ruichao Zhu[1], Alexander R. Munoz[2a], and S. R. J. Brueck
Center for High Technology Materials, University of New Mexi co, Albuquerque, NM, 87106

Sharwan Singhan and S. V. Sreenivasan
Microelectronics Research Center and Department of Mechanical Engineering, University of Texas at Austin, Austin, TX

Scatterometry is very important as a fast, non-contact, non-destructive in-line nanoscale metrology tool. Relatively few reports have discussed the extension of scatterometry to the extreme sub-wavelength scales that will be necessary as nanotechnology manufacturing scales decrease. As a start towards this goal, we have carried out scatterometry studies of a 50-nm half-pitch wire-grid polarizer with an Al grating on top of a fused silica substrate fabricated by nano-imprint lithography and anisotropic etching. In particular, the limits of scatterometry as both the pitch and the CD become << the scatterometry wavelength have not been fully explored.

Multiple wavelength sources (244nm, 405nm and 633nm) are used as the incident beam source. The reflection (0-order diffraction) is measured for incident angles of 8°-80° for all non-conical combinations of incident polarization and grating orientation. Rigorous coupled wave analysis (RCWA) is used for simulations. The grating profile is characterized by seven parameters (pitch, linewidth, topwidth, fused silica undercut depth, Al thickness, and horizontal and vertical extent of the top rounding, see Fig. 1). The simulations act as a baseline library for fitting the scatterometry measurements.

Our results (Table I) show that all the three wavelengths have enough capability to measure the 100 nm pitch size, but as expected the sensitivity of the fit increases at shorter wavelengths . Results of 244nm and 633nm have a good agreement at the pitch while the result of 405nm has some deviation. This is likely as result of the multi-mode character of this laser compared the single-mode TEM_{00} character of the other sources. We also compare the results of scatterometry with scanning electron microscope (SEM) images (Fig. 2). All of the measurements show a similar grating profile, but the observed precisions (repeatability) is better than the accuracy, given the different. There are also some discrepancies between the scatterometry grating profile and the scanning electron microscope (SEM) image which can be explained in terms of excess scattering from metallic structures and the finite beam size of the SEM.[3]

[1] ruichao@unm.edu
[2] Present address: Arizona State University, Tempe, AZ
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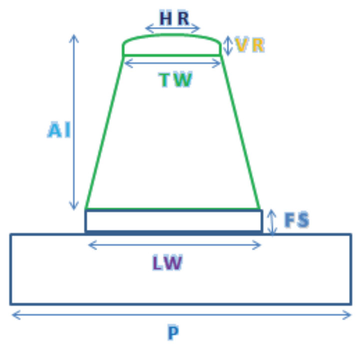

Figure 1: The grating profile is characterized by seven parameters: pitch (P), line width (LW), top width (TW), fused silica undercut depth (PS), Al thickness (AL), and horizontal and vertical extent of the top rounding (HR,VR)

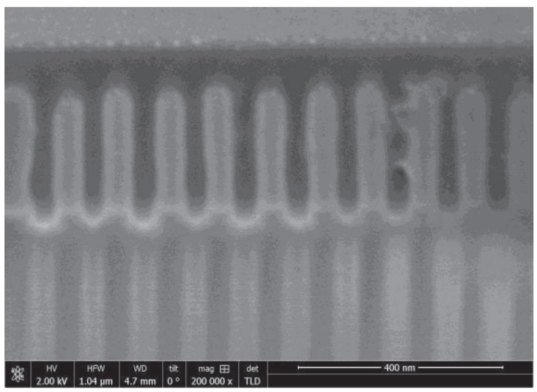

Figure 2: SEM image of the wire-grid polarizer sample with the Al grating on the fused silica substrate using focused-ion beam etching.

(nm)	P	LW	TW	Al	FS	HR	VR
244nm	93.2	37.8	53.2	222.6	38	34.0	12.6
405nm	84.8	43.4	48.8	242.5	NA	19.6	38.3
633nm	93.3	50.8	62.6	189.7	28	33.8	18.7
SEM	93.1	52.4	54.5	219.2	26	25.3	36.7

Table 1: Scatterometry and SEM fitting results.