Effects of Roughness on Scatterometry Signatures

M. Foldyna[1], T. A. Germer[2], and B. C. Bergner[3]

[1]*Laboratory of Interfaces and Thin Films, CNRS, Ecole Polytechnique, 91128 Palaiseau, France*
[2]*Optical Technology Division, National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899-8443, USA*
[3]*Spectum Scientific, Inc., 16692 Hale Avenue, Irvine, CA 92606, USA*

ABSTRACT

Recent development in the optical characterization allows using more complex experimental methods in order to characterize periodic structures [1]. The new trend is to examine potential of the Mueller matrix and multi-configuration methods in order to access the most challenging problems of the optical metrology. In this work we are going to present results acquired on the artificially perturbed periodic line grating with significant line width roughness (LWR). The method used in this work is based on the generalized ellipsometry, which provides not only the spectrally resolved Δ and ψ, but also eleven elements of the Mueller matrices.

Application of the multi-azimuth method allows for the robust analysis of the perturbed and unperturbed gratings [2] with an estimation of the model parameters accuracy. Moreover, using Mueller matrices provides extra advantages including: the information in the block off-diagonal elements for different conical configurations; the estimation of the measured data accuracy by combining adequate configurations; the complete description of the depolarization effects. Our situation is slightly complicated by experimental conditions requiring significant focusing of the incident light beam into the small feature area. The focused incident beam leads to Mueller matrices with significant depolarization characteristics which have to be taken into account also in the optical model. The effect is more pronounced in spectral regions, where the signal changes very fast.

Recent theoretical works on the sensitivity of angularly resolved data to the LWR [3,4] demonstrated significance of the problem and explored limits of effective medium approximations for the purpose of LWR modeling. In this work, we are more focused on modeling of perturbed periodic structures (see Fig. 1) using the rigorous coupled-wave method and evaluating of the sensitivity of the experimental spectrally resolved data to the dimensional parameters of LWR.

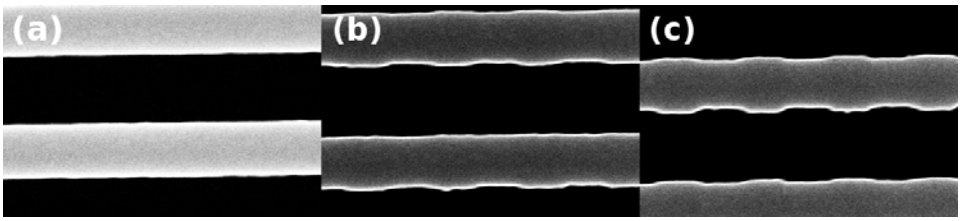

FIGURE 1. Scanning electron microscopy images of diffraction gratings with artificially manufactured line-width roughness. The amplitudes of modulation as a fraction of the unperturbed line-width are: (a) unperturbed; (b) 2%; and (c) 5%.

REFERENCES

1. M. Foldyna, A. De Martino, C. Licitra, J. Foucher, *Proc. of SPIE* **7638**, 763803 (2010).
2. M. Foldyna, T.A. Germer, B.C. Bergner, *Thin Solid Films*, accepted.
3. B.C. Bergner, T.A. Germer, and T.J. Suleski, *Proc. of SPIE* **7272**, 72720U (2009).
4. B.C. Bergner, T.A. Germer, and T.J. Suleski, *J. Opt. Soc. Am. A* **27**, 1083 (2010).