Accurate Analysis of Practical Diffraction Gratings

H. A. Kalhor and M. R. Zunoubi
State University of New York, USA

Diffraction gratings have been used in many applications including spectroscopy for many years. Many ingenious approximate, analytical, and numerical techniques have been devised and used for their analysis. However, most of the proposed techniques used idealized models. The structures have been considered infinitely periodic, perfectly conducting and without groove shape imperfections. Attempts have been made to incorporate some imperfections such as finite conductivity and groove shape errors in the idealized models with some success [1–4]. Theoretical and measurement results, however, did not agree in many cases and certain anomalous behavior could not be explained. More recently, a method based on impedance boundary conditions has been proposed to analyze finite planar and curved frequency selective surfaces [5].

Recent developments of new and powerful numerical methods have empowered researchers to study the effects of these imperfections more accurately, and revisiting these classical problems seems in order.

The object of this presentation is to study the performance of practical gratings with all their associated imperfections accurately. A few numerical techniques will be employed and compared and contrasted. The behavior of reflection diffraction gratings of practical interest such as echelette sinusoidal, and lamellar as well as transmission gratings made of wire grids, conducting cylinders, and conducting bars will be studied. Comparison with experimental results will be made where possible.

REFERENCES

1. Kalhor, H. A. and A. R. Neureuther, "Effects of conductivity, groove shape, and physical phenomena on the design of diffraction grating," *J. Opt. Soc. Am.*, Vol. 63, No. 11, 1412–1418, 1973.
2. Christodoulou, C. and J. Kauffman, "On the electromagnetic scattering from infinite rectangular grids with finite conductivity," *IEEE Trans. Antennas Propag.*, Vol. 34, No. 2, 144–154, Feb. 1986.
3. Abboud, T. and H. Ammari, "Diffraction at a curved grating: approximation by an infinite plane grating," *J. Math. Anal. and App.*, Vol. 202, 1076–1100, 1996.
4. Whites, K. W. and R. Mittra, "An equivalent boundary-condition model for lossy planar periodic structures at low frequency," *IEEE Trans. Antennas Propag.*, Vol. 44, No. 12, 1617–1629, Dec. 1996.
5. Stupfel, B. and Y. Pion, "Impedance boundary conditions for finite planar and curved frequency selective surfaces," *IEEE Trans. Antennas Propag.*, Vol. 53, No. 4, 1415–1425, April 2005.