Analytical Model for Planar Strip–like Blazed Gratings

C. Molero(1), R. Rodríguez-Berral(2), F. Medina*(3), F. Mesa(2), M. Memarian(4), and T. Itoh(5).
(1) Institut d'Electronique et de Telecommunications de Rennes (IETR), UMR CNRS 616, INSA Rennes, 35708 Rennes, France.
(2) Dept. de Física Aplicada I, ETSII, Av. Reina Mercedes s/n, 41012, Seville, Spain.
(3) Dept. de Electrónica y Electromagnetismo, Universidad de Sevilla, Facultad de Física, Av. Reina Mercedes s/n, 41012, Seville, Spain. email: medina@us.es.
(4) Dep. of Electrical Engineering, Sharif University of Technology, Tehran, Iran.
(5) Dep. of Electrical Engineering, UCLA, Los Angeles, CA, USA.

Blazed gratings (or "echelette" gratings) are a kind of diffraction grating designed to eliminate the specular reflection by proper transfer of the impinging power (supported by the zeroth order Floquet harmonic) to a chosen high-order harmonic (typically, this harmonic use to be the n = - 1 order). A variety of designs performing this functionality have been available for many decades. Corrugated dielectric or metallic surfaces with sawtooth or simple rectangular profiles are very popular implementations of this kind of gratings. In the microwaves, millimeter-wave and THz regimes the use of printed planar structures is a convenient and simple manner of creating a blazing structure. Thus, a resonant based metasurface grating was proposed recently by some of the authors [1]. However, it was soon demonstrated that a structure as simple as an array of metal strips printed on a conductor backed dielectric slab, if properly designed, also exhibits this phenomenology [2].

The determination of the dimensions of the strips, thickness and permittivity of the substrate and periodicity requires, in principle, the use of some full-wave solver to determine the reflection coefficient of the structure within the Bragg diffraction regime. However, thanks to the simplicity of the geometry of the strip–like configuration, an analytical solution to the problem might be achieved. Analytical models based on accurate equivalent circuits for this class of geometries have been developed in the past by some of the authors [3]. That methodology has been applied to the blazing structure in [2] to obtain an analytical solution for the specific case of blazing occurring along the Bragg line [4]. This case is particularly simple and straightforward determination of the period and strip width is possible. In this contribution it is shown that perfect off-Bragg specular reflection is also predicted by the circuit model. Thus, the design of the blazed reflection grating in order to accommodate an arbitrary angle of emission is possible using the analytical model. The model provides a fast design tool and a better understanding of the physics behind the studied phenomenon.

References

[1] M. Memarian *et al.*, "Resonant blazed metasurface gratings," in *Proc. of 46th European Microw. Conf.*, pp. 297-300, (London, UK), 4-6 Oct. 2016.

[2] M. Memarian *et al.*, "Wide-band/angle blazed surfaces using multiple coupled blazing resonances," *Sci. Reports*, vol. 7, art. 42286, Feb. 2017.

[3] R. Rodríguez-Berral *et al.*, "Analytical wide- band model for strip/slit gratings loaded with dielectric slabs," *IEEE Trans. Microw. Theory Techn.*, vol. 60, no. 12, pp. 3908-3918, Dec. 2012.

[4] C. Molero *et al.*, "Accurate circuit model for a planar resonant blazed grating," in *Proc. of 47th European Microwave Conference*, pp. 775-778, (Nuremberg, Germany), 8-13 Oct. 2017.