An Infinite Array of Dielectric-Loaded Slots in a Metallic Shield of Finite Thickness

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Metasurfaces have recently been the object of much research, not least because of the large number of promising applications (such as filters, absorbers, beam steerers, sensors and many others). Their smaller size, lighter weight and ability to conform to a variety of surface shapes gives metasurfaces significant advantages over other techniques that might be used for the same purpose. One possible application of metasurfaces involves the phenomenon of extraordinary transmission: the strong transmission of a wave through an aperture that is small compared to a wavelength. This has been done in the past using cooperative interference between a large number of apertures in a thick conducting screen (T. W. Ebbesen et al., Nature, 391, 667-669, 1998).

As a natural extension of our previous works (A. Haddab and E. F. Kuester, "Extraordinary transmission of an electromagnetic wave through a dielectric-loaded slot in a metallic shield of finite thickness," National Radio Science Meeting, 4-7 January 2017, Boulder, CO, paper B6-7; "Effect of higher-order modes on extraordinary transmission through a dielectric-loaded slot in a thick metallic shield," IEEE Antennas and Propagation and USNC-URSI Radio Science Meeting, 9-14 July 2017, San Diego, CA, pp. 459-460), a metasurface consisting of an array of dielectric-loaded slots in a metallic shield of finite thickness is investigated in this paper.

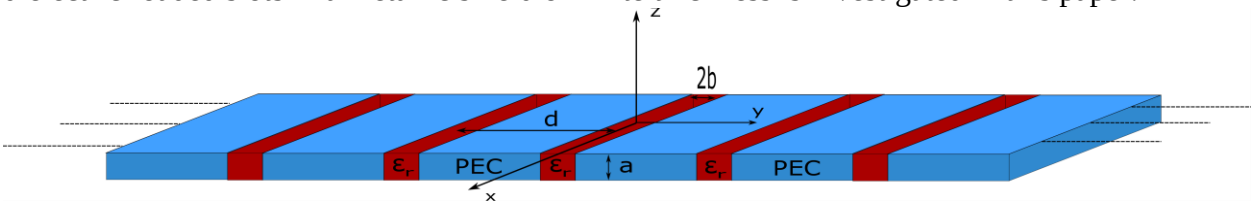

Figure 1 Infinite array of loaded dielectric slots.

The mode-matching method is used to analyze this problem, and we obtain an analytical expression for the transmission coefficient S_{12} through the slot array when the relative permittivity of the material loading the slots is large compared to one. Resonances of the parallel-plate waveguide modes in the slot are found to produce extraordinary transmission at certain frequencies. The analytical results will be compared with those obtained using numerical finite-element simulation software (HFSS).