Plane Wave Diffraction by a Thin Material Strip

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The analysis of the scattering by material strips is an important subject in electromagnetic theory and radar cross section (RCS) studies. Volakis analyzed the H-polarized plane wave diffraction by a thin material strip using the dual integral equation approach and the extended spectral ray method together with approximate boundary conditions [1]. In [1], Volakis first solved rigorously the diffraction problem involving a single material half-plane, and subsequently obtained a high-frequency solution to the original strip problem by superposing the singly diffracted fields from the two independent half-planes and the doubly/triply diffracted fields from the edges of the two half-planes. Therefore his analysis is not rigorous from the viewpoint of boundary value problems, and may not be applicable unless the strip width is relatively large compared with the wavelength. In this paper, we shall consider the same problem as in Volakis [1], and analyze plane wave diffraction by a thin material strip for both H and E polarizations using the Wiener-Hopf technique together with the two different approximate boundary conditions [2, 3]. Main results of this paper are published in Nagasaka and Kobayashi [4, 5].

The geometry of the strip is shown in Figure 1, where ε_r and μ_r denote the relative permittivity and the relative permeability of the material, respectively, and ϕ^i is the incident field of H or E polarization. Introducing the Fourier transform of the scattered field and applying approximate boundary conditions in the transform domain, the problem is formulated in terms of the Wiener-Hopf equations, which are solved exactly via the factorization and decomposition procedure. However, the solution is formal in the sense that branch-cut integrals with unknown integrands are involved. By employing a rigorous asymptotic method, we shall derive a high-frequency solution of the Wiener-Hopf equations, which is valid for the strip width greater than about the incident wavelength. The scattered field in the real space is evaluated asymptotically by taking the Fourier inverse of the solution in the transform domain and applying the saddle point method. Numerical examples of the RCS are presented for various physical parameters and far field scattering characteristics of the strip are discussed. Some comparisons with other existing methods are also provided and the validity of our approach is discussed.

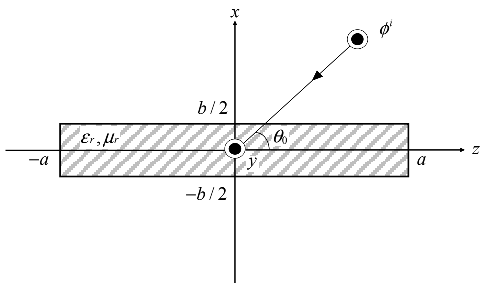

Figure 1. Geometry of the strip.

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