Plane Wave Diffraction by a Thin Material Strip

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Analysis of the scattering by imperfectly conducting and absorbing strips is an important subject in electromagnetic theory, and it is relevant to many engineering applications such as antenna and radar cross section (RCS) studies. A resistive sheet can be regarded as a suitable model of thin lossy material layers and there have been investigations on the scattering by resistive strips based on several analytical and numerical methods. It is known that a thin material layer with arbitrary permittivity and permeability can be modeled by a pair of modified resistive and conductive sheets each satisfying given boundary conditions [1]. In a previous paper [2], we have analyzed the plane wave diffraction by a thin, two-dimensional (2D) dielectric strip using a new analytical-numerical approach [3] based on the orthogonal polynomial expansion together with approximate boundary conditions, where an efficient solution has been obtained for the strip thickness small compared with the wavelength. In this paper, we shall consider a thin 2D strip consisting of a homogeneous material with arbitrary permittivity and permeability as a generalization to our previous geometry in [2], and analyze the plane wave diffraction for both E and H polarizations. The solution method is again based on the analytical-numerical approach and approximate boundary conditions.

We consider the material strip of relative permittivity ε_r and relative permeability μ_r, being illuminated by a plane electromagnetic wave, where the strip occupies the region $|x| < a$ and $|y| < b/2$ on the xy plane. The material strip is approximately replaced by a strip of zero thickness satisfying the boundary condition corresponding to modified resistive and conductive sheets [1] under the condition that the strip thickness is small compared with the wavelength. Applying the approximate boundary conditions to an integral representation of the scattered field, the problem is formulated as two integral equations satisfied by the unknown current density functions. Expanding the current density functions in terms of the orthogonal polynomials, our problem is reduced to the solution of two infinite systems of linear algebraic equations (SLAE) satisfied by the unknown expansion coefficients. These coefficients are determined numerically with high accuracy via appropriate truncation of the SLAE. The scattered field is evaluated asymptotically and a far field expression is derived. Illustrative numerical examples on the RCS are presented, and the far field scattering characteristics of the strip are discussed in detail. Some comparisons with a high-frequency technique [4] are also given to validate the present method.

REFERENCES

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