A Semi-analytical Method for TE Scattering from Arbitrary Shaped Radially Inhomogeneous Cylindrical Shells at Normal Incidence

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Abstract— Radially inhomogeneous cylindrical shells, whose electrical properties vary continuously along the radial direction only, are encountered in various engineering applications. Analytical solutions of the electromagnetic scattering problems related to such structures are available for some specific inhomogeneity profiles [1, 2]. These solutions consider inhomogeneous cylindrical shells with simple (circular or elliptical) boundaries. However, for practical purposes, circular radially inhomogeneous shells can be deformed with notches or grooves or can be used for shielding noncircular cores. For such shells having arbitrary shaped boundaries, conventional discretization-based computational methods, which might be computationally expensive especially for electrically large objects, can be used. In [3], we proposed a fast meshless method to compute the electromagnetic field scattered from an arbitrary shaped radially inhomogeneous cylindrical shell for the TM illumination case. Here, we adapt this method to the TE illumination case. In this method, the field component to be computed (\(E_z\) for the TM case, \(H_z\) for the TE case) is represented as a series of the general solutions of a governing differential equation at each layer (the core, the shell, and the outermost medium). In the inhomogeneous shell, the governing differential equations and accordingly their general solutions are different for the TM and TE cases as well as for different inhomogeneity profiles. In order to determine the unknown coefficients of the series representations of the fields, first the continuity conditions are imposed and two equations are obtained at each boundary between the layers. Then we take the inner products of these equations with complex exponential functions and, in virtue of the orthogonality of complex exponentials, obtain a linear system of equations at each boundary. Finally, the unknown coefficients are extracted from the two linear systems and consequently, the field components at each layer are obtained. Numerical results show that the proposed method is accurate and effective also for the TE illumination case.

REFERENCES