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Analysis of scattering from cylindrical structures coated by radially inhomogeneous layer using Taylor's series method

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Consider a cylindrical structure with an arbitrary core coated by a radially inhomogeneous layer in a general case. The core of the structure may be PEC, PMC, PEMC, impedance boundary, dielectric, or metamaterial. Contrary to the scattering problems of homogeneous media, scattering problems of inhomogeneous media do not have exact solutions except for special inhomogeneous profiles. In this paper, a general frequency domain method is proposed to analyze scattering from such structures on the basis of Taylor's series concept for obliquely incident electromagnetic (EM) waves with arbitrary polarizations. The validity of the suggested method is verified by comparison with the exact solutions of some special profiles for the coating layer. Furthermore, a comparison is made between the proposed method and other commonly used methods in the literature, which confirms that the proposed method is general, fast, and has good convergence toward the solution. Moreover, as an application, we employed the method for optimization of the scattering echo width of a PEC cylinder.

Keywords: scattering; cylindrical inhomogeneous media; propagation; scattering echo width reduction

1. Introduction

Cylindrical structures are of the most applicable structures in engineering electromagnetic. Finding a proper coating for these structures is always a purpose of researchers to optimize radar cross section, shielding effectiveness and to achieve an arbitrary radiation pattern.[1–6] Actually, the use of inhomogeneous media as coatings in these structures, like inhomogeneous planar structures, can yield appealing results for radar absorber design, filter, and shielding optimization.[7–12]

So far, a number of several investigations have been carried out to analyze scattering of EM plane waves from cylindrical structures with coatings. The pioneering works on the subject were limited to scattering from cylindrical structures coated by homogeneous layers at normal incidence.[13–15] Then the more complicated problem of scattering by cylinders coated with either a single [16] or multiple [17] homogeneous layer at oblique incidence were analyzed. Scattering from cylinders with radially inhomogeneous coating were analyzed in [18] for the normal incidence. Moreover, in other studies, special inhomogeneous profiles were assumed for the coating layer [19–21] or the approach was based on stratifying the inhomogeneous layer into several homogeneous

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