Plane Wave Scattering by a Circular PEMC Cylinder Coated with Anisotropic Media

Nasser Montaseri, Ali Abdolali, Mohammad Soleimani, Vahid Nayyeri

Antenna Research Laboratory, School of Electrical Engineering, Iran University of Science and Technology (IUST), Iran

Received 20 February 2012; accepted 28 May 2012

ABSTRACT: Analytical solution of plane wave scattering by a circular PEMC (Perfect Electromagnetic Conductor) cylinder coated with anisotropic media was presented in this article. When referred to principal axes (ρ, ϕ,z) in the anisotropic region, both permittivity and permeability tensors were biaxial and diagonal; so, the radial Eigen-functions were complex ordered Bessel's functions. The monostatic and bistatic scattering cross-sections of a PEMC cylinder coated with both of anisotropic DPS (double-positive) medium with positive values of relative permittivity and elements of permeability tensors and anisotropic DNG (double-negative) metamaterial with negative values of relative permittivity and permeability elements of tensors were calculated. The validity of the presented relations was achieved by comparing the results of specific cases of isotropic coated cylinder and anisotropic coated perfect electric conductor cylinder with those of previously published methods. © 2012 Wiley Periodicals, Inc. Int J RF and Microwave CAE 00:000–000, 2012.

Keywords: anisotropic media; co-polarized scattered fields and cross-polarized scattered fields; electromagnetic scattering; perfect electromagnetic conductor boundary

I. INTRODUCTION

Perfect electromagnetic conductor (PEMC) medium, which has been recently introduced by Lindell and Sihvola [1], is described by the following relations

$$\vec{H} + M\vec{E} = 0 \tag{1}$$

$$\vec{D} - M\vec{B} = 0 \tag{2}$$

where M is a scalar real parameter denoting the PEMC admittance. PEMC is the nonreciprocal generalization of both perfect electric conductor (PEC) ($M \to \pm\infty$) and perfect magnetic conductor ($M = 0$). For real values of M, one can easily show that the complex pointing vector is an imaginary one. Hence, the field cannot convey energy to a PEMC medium [2]. As a result, PEMC is considered an ideal boundary, which has the following boundary condition [3].

$$\hat{n} \times (\vec{H} + M\vec{E}) = 0 \tag{3}$$

where $\hat{n}$ denotes the unit vector normal to the boundary.

Correspondence to: N. Montaseri; e-mail: montaseri@elec.iust.ac.ir

DOI 10.1002/mmce.20668

Published online in Wiley Online Library (wileyonlinelibrary.com).

The PEMC was initially introduced as a purely conceptual medium. Afterwards, the realization of PEMC boundary has been investigated in several studies and some approaches have been theoretically introduced [3]. Recently, a grounded ferrite slab has been proposed that practically represents a PEMC boundary condition [4]. Although realization of PEMC is challenging, it may have potential applications in microwave engineering as well as antenna engineering [5].

Electromagnetic wave interaction with PEMC objects has been massively investigated. For example, the basic problem of reflection and transmission of an obliquely incident plane wave at the interface of a PEMC half space or slab was illustrated in [6]. Furthermore, the analytical solution of scattering from infinite PEMC cylinder and PEMC sphere was developed in [7, 8]. Then, the scattering by a PEMC circular cylinder coated with isotropic media layer was considered in [9–13]. Since composite materials such as metamaterials have been extensively applied for coating the objects and, due to the anisotropic property of these metamaterials, the problem of scattering by an object coated with anisotropic media [14–20] as well as metamaterials [21–23] has been of interest and of value and has been extensively investigated. However, scattering by a PEMC cylinder coated with anisotropic media has not been studied yet. Thus, in this article, the