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ELECTROMAGNETIC RESPONSE OF A CIRCULAR DB CYLINDER IN THE PRESENCE OF CHIRAL AND CHIRAL NIHILITY METAMATERIALS

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Abstract—Scattering of electromagnetic plane wave from an infinitely long circular DB cylinder placed in chiral and chiral nihility metamaterials is studied, and the results are compared with that of scattering from DB cylinder placed in free space. The discussion is further extended by considering coating of DB cylinder with chiral/chiral nihility metamaterial. For DB cylinder placed in unbounded free space/chiral/chiral nihility metamterial, only co-polarized scattered fields are obtained, whereas, for chiral/chiral nihility metamaterial coated case, both co- and cross-polarized scattered fields are noted. Numerical results are presented for different values of chirality parameter.

1. INTRODUCTION

Chiral media are composed of randomly oriented chiral objects which cannot be superimposed with their mirror images by any translation or rotation. Chiral metamaterial is the interest of many researchers and engineers from last many decades, and numerous articles by different authors are contributed on electromagnetic scattering form chiral objects or objects placed in chiral medium. Jaggard et al. [1], Lakhtakia et al. [2, 3] and Lindell et al. [4] discussed the behavior of electromagnetic waves in chiral medium. Scattering of electromagnetic waves by a perfectly conducting body with chiral coating was studied by Dmitrenko and Korogodov [5]. Kluskens and Newman [6] studied scattering from chiral cylinder of arbitrary cross section. Lakhtakia [7, 8] introduced the concept of nihility medium.

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Nihility medium is defined to be one which is characterized by zero permittivity and permeability. This concept attracted the attention of many researchers. Tretyakov et al. [9, 10] applied nihility concept on isotropic chiral medium. Qiu et al. [11] discussed chiral nihility effects on energy flow in chiral material. Cheng et al. [12] contributed an article on manifestation of negative refraction in chiral nihility media. Cheng et al. [13] studied the behavior of waves in planar waveguide containing chiral nihility metamaterial. Naqvi [14] has published corrections in the study of [13]. Naqvi discussed fractional dual solutions to Maxwell equations in chiral nihility medium [15]. Bohren studied scattering from an optically active cylinder [16]. Scattering from dielectric/chiral coated nihility cylinder is discussed by Ahmed and Naqvi [17, 18]. Dong et al. [19–23] also studied various field problems concerning chiral nihility metamaterial. Li and Shen [24] analyzed scattering by a conducting cylinder coated with metamaterial.

In electromagnetic problems, boundary conditions are generally expressed in terms of tangential components of fields at the interfaces. However, it has been shown by Rumsey [25] that these boundary conditions can also be expressed in terms of normal field components. These boundary conditions were rediscovered in the problems dealing with invisibility cloak [26–28]. The so called DB boundary conditions for the normal components of flux densities, introduced by Lindell and co-workers [29–33], are given as

$$\hat{n}\cdot\mathbf{D} = 0 \tag{1a}$$

$$\hat{n}\cdot\mathbf{B} = 0 \tag{1b}$$

$\mathbf{D}$ and $\mathbf{B}$ are electric and magnetic flux densities, respectively, and $\hat{n}$ is normal unit vector. Using above mentioned boundary conditions, Sihvola et al. [34] analyzed the scattering from DB sphere. Spherical resonator and circular waveguide with DB boundary conditions are discussed by Lindell and Sihvola [35, 36]. Recently Naqvi et al. [37] contributed an article dealing with a planer DB interface placed in chiral and chiral nihility metamaterial. They found an interesting result that there are no backward reflected waves in chiral nihility medium backed by planar DB interface.

In this paper, we present a study of scattering from circular coated and un-coated DB cylinder placed in free space and chiral/chiral nihility mediums. Section 2 deals with DB cylinder placed in free space, Section 3 presents DB cylinder placed in chiral/chiral nihility medium. And chiral and chiral nihility coated DB cylinder placed in free space is analyzed in Section 4. Finally, numerical results are presented. Time dependence $e^{j\omega t}$ is used and suppressed throughout the analysis. The length of the cylinder is assumed to be infinite and its axis is coincident with z-axis of the coordinate system.

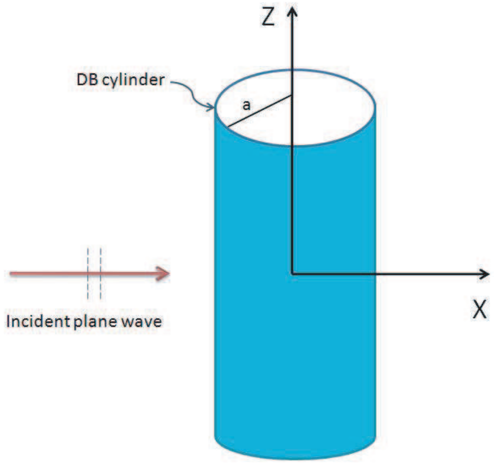

Figure 1. Circular DB cylinder placed in free space.

2. DB CYLINDER PLACED IN FREE SPACE

We consider a circular DB cylinder of radius a, placed in free space, as shown in Figure 1.

The constitutive relations for free space are

$$\mathbf{D} = \epsilon_o \mathbf{E} \tag{2a}$$
$$\mathbf{B} = \mu_o \mathbf{H}, \tag{2b}$$

where (ϵ_o, μ_o) are constitutive parameters of free space. For this geometry, the electromagnetic fields can conveniently be represented by cylindrical vector wave functions as given by [38]

$$\mathbf{N}_n^{(p)}(k) = \hat{z} Z_n^{(p)}(k\rho) e^{jn\phi} \tag{3a}$$
$$\mathbf{M}_n^{(p)}(k) = \hat{\rho} \frac{jn}{k\rho} Z_n^{(p)}(k\rho) e^{jn\phi} - \hat{\phi} Z'^{(p)}_n(k\rho) e^{jn\phi}. \tag{3b}$$

The vector wave functions $\mathbf{M}_n$ and $\mathbf{N}_n$ are related by

$$\nabla \times \mathbf{N}_n = k\mathbf{M}_n \quad \nabla \times \mathbf{M}_n = k\mathbf{N}_n,$$

where $p = 1, 2$ ($Z_n^{(1)} = J_n$, $Z_n^{(2)} = H_n^{(2)}$) and the prime denotes the derivative with respect to the argument. In above set of equations, k is the wavenumber of a medium which in present case is $k = k_o = \omega\sqrt{\mu_o \epsilon_o}$.

The surface of cylinder can be excited by TM or TE polarized fields. For TM^z case the incident plane wave in terms of cylindrical vector wave function can be expressed as [39]

$$\mathbf{E}_{inc} = \sum_{n=-\infty}^{+\infty} j^{-n}\mathbf{N}_n^{(1)}(k_o) \tag{4a}$$

$$\mathbf{H}_{inc} = \frac{j}{\eta_o}\sum_{n=-\infty}^{+\infty} j^{-n}\mathbf{M}_n^{(1)}(k_o). \tag{4b}$$

For TE^z case the incident fields are

$$\mathbf{E}_{inc} = \sum_{n=-\infty}^{+\infty} j^{-n}\mathbf{M}_n^{(1)}(k_o)$$

$$\mathbf{H}_{inc} = \frac{j}{\eta_o}\sum_{n=-\infty}^{+\infty} j^{-n}\mathbf{N}_n^{(1)}(k_o).$$

For TM^z case the scattered fields from the surface of cylinder are given below

$$\mathbf{E}_{sca} = \sum_{n=-\infty}^{+\infty} j^{-n}a_n\mathbf{N}_n^{(2)}(k_o) \tag{5a}$$

$$\mathbf{H}_{sca} = \frac{j}{\eta_o}\sum_{n=-\infty}^{+\infty} j^{-n}a_n\mathbf{M}_n^{(2)}(k_o) \tag{5b}$$

By using DB boundary conditions, the unknown coefficients a_n $\rho = a$ are found to be

$$a_n = -\frac{J_n(k_o a)}{H_n^{(2)}(k_o a)}. \tag{5c}$$

Similarly scattered fields for TE^z incident fields can be determined. It is clear from (5) that for TM^z case, with respect to axis (z-axis) of the cylinder, DB cylinder behaves as PEC cylinder whereas for TE^z case the DB cylinder behaves as PMC cylinder. Similar results were shown by Lindell and Sihvola [29] for planar DB interface.

3. DB CYLINDER PLACED IN CHIRAL/CHIRAL NIHILITY MEDIUM

In this section, a circular DB cylinder of radius a placed in isotropic, homogeneous, and lossless chiral medium is analyzed. The geometry of the problem is similar to that in Figure 1, but now DB cylinder is placed in chiral metamaterial instead of free space. The constitutive relations for chiral medium, with constitutive parameters (ϵ, μ, κ), are given as [4]

$$\mathbf{D} = \epsilon\mathbf{E} + j\kappa\mathbf{H} \tag{6a}$$

$$\mathbf{B} = \mu\mathbf{H} - j\kappa\mathbf{E}, \tag{6b}$$

where κ is the chirality parameter, $\epsilon = \epsilon_c\epsilon_o$ the permittivity, and $\mu = \mu_c\mu_o$ the permeability of chiral medium. As chiral metamaterial supports circularly polarized modes, therefore, the incident field can be right circularly polarized (RCP) and/or left circularly polarized (LCP). The incident RCP and LCP waves can be written by using vector wave functions $\mathbf{M}_n$ and $\mathbf{N}_n$ as shown by [16]

$$\begin{aligned}\mathbf{E}_{R,n} &= \mathbf{M}_n^{(1)}(k_R) + \mathbf{N}_n^{(1)}(k_R)\\ \mathbf{E}_{L,n} &= \mathbf{M}_n^{(1)}(k_L) - \mathbf{N}_n^{(1)}(k_L),\end{aligned}$$

where, $\mathbf{M}_n^{(1)}$ and $\mathbf{N}_n^{(1)}$ are defined by Equation (3). Two wavenumbers $k_{R,L}$ for chiral medium are given by

$$k_{R,L} = \omega(\sqrt{\mu\epsilon} \pm \kappa). \tag{7}$$

We consider normal incidence of right circularly polarized (RCP) wave. Incident electromagnetic fields in terms of cylindrical vector wave functions are

$$\begin{aligned}\mathbf{E}_{inc} &= \sum_{n=-\infty}^{+\infty} j^{-n}\left[\mathbf{M}_n^{(1)}(k_R) + \mathbf{N}_n^{(1)}(k_R)\right]\\ \mathbf{H}_{inc} &= \frac{j}{\eta}\sum_{n=-\infty}^{+\infty} j^{-n}\left[\mathbf{M}_n^{(1)}(k_R) + \mathbf{N}_n^{(1)}(k_R)\right]\end{aligned}$$

where $\eta = \sqrt{\mu/\epsilon}$ is the impedance of the chiral medium. The scattered fields in terms of RCP and LCP vector wave functions can be written as

$$\mathbf{E}_{sca} = \sum_{n=-\infty}^{+\infty} j^{-n}\left[a_n\left(\mathbf{M}_n^{(2)}(k_R) + \mathbf{N}_n^{(2)}(k_R)\right) + b_n\left(\mathbf{M}_n^{(2)}(k_L) - \mathbf{N}_n^{(2)}(k_L)\right)\right]$$

$$\mathbf{H}_{sca} = \frac{j}{\eta}\sum_{n=-\infty}^{+\infty} j^{-n}\left[a_n\left(\mathbf{M}_n^{(2)}(k_R) + \mathbf{N}_n^{(2)}(k_R)\right) - b_n\left(\mathbf{M}_n^{(2)}(k_L) - \mathbf{N}_n^{(2)}(k_L)\right)\right].$$

In aforementioned equations, a_n and b_n are unknown coefficients. By applying the DB boundary conditions (1) at $\rho = a$ the coefficients can be shown to be

$$a_n = -\frac{J_n(k_R a)}{H_n^{(2)}(k_R a)} \qquad b_n = 0.$$

Let us assume that the DB cylinder in Figure 1 is now placed in chiral nihility metamaterial, instead. Chiral nihility medium is a medium with constitutive parameters $\epsilon \to 0$, $\mu \to 0$ and $\kappa \neq 0$. The characteristic impedance of the chiral nihility medium is $\eta = \lim_{\epsilon,\,\mu\to 0}\sqrt{\mu/\epsilon}$. The constitutive relations for chiral nihility medium become [8]

$$\mathbf{D} = i\kappa\mathbf{H} \tag{8a}$$

$$\mathbf{B} = -i\kappa\mathbf{E}. \tag{8b}$$

The wavenumbers, in this case, simplify to

$$k_{R,L} = \pm\omega\kappa \tag{9a}$$

$$k_R = -k_L \tag{9b}$$

The unknown coefficients, in this case, are

$$a_n = -\frac{J_n(k_R a)}{H_n^{(2)}(k_R a)} \qquad b_n = 0.$$

In view of above results it is clear that the DB cylinder placed in chiral and chiral nihility medium behaves as a perfect scatterer like PEC/PMC cylinder. Moreover, there is no backward phenomenon in chiral nihility medium.

4. CHIRAL/CHIRAL NIHILITY COATED DB CYLINDER

Now, we consider a DB circular cylinder, uniformly coated with isotropic, homogeneous, and lossless chiral metamaterial. Radius of the DB cylinder is a while chiral coated DB cylinder has radius b. The region $\rho > b$ is free space while the region $a < \rho < b$ is chiral medium with constitutive parameters (ϵ, μ, κ) and impedance $\eta = \sqrt{\mu/\epsilon}$. The chiral coated DB cylinder placed in free space is shown in Figure 2. The constitutive relations and wavenumbers for chiral media are given by Equations (6) and (7), respectively.

This section presents the solution for TM^z fields normally incident on coated geometry. The incident fields are

$$\mathbf{E}_o^{inc} = \sum_{n=-\infty}^{+\infty} j^{-n}\mathbf{N}_n^{(1)}(k_o) \tag{10a}$$

$$\mathbf{H}_o^{inc} = \frac{j}{\eta_o}\sum_{n=-\infty}^{+\infty} j^{-n}\mathbf{M}_n^{(1)}(k_o). \tag{10b}$$

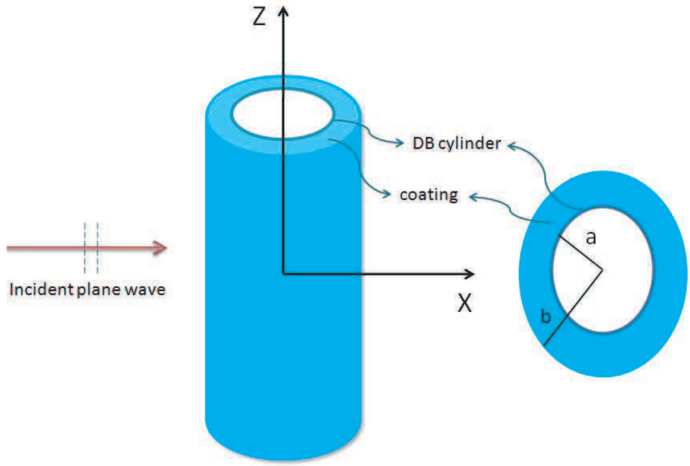

Figure 2. Circular coated DB cylinder placed in free space.

The scattered fields in free space, $\rho > b$, are written as superposition of TM^z and TE^z fields as

$$\mathbf{E}_o^{sca} = \sum_{n=-\infty}^{+\infty} j^{-n} \left[a_n \mathbf{N}_n^{(2)}(k_o) + b_n \mathbf{M}_n^{(2)}(k_o) \right]$$

$$\mathbf{H}_o^{sca} = \frac{j}{\eta_o} \sum_{n=-\infty}^{+\infty} j^{-n} \left[a_n \mathbf{M}_n^{(2)}(k_o) + b_n \mathbf{N}_n^{(2)}(k_o) \right].$$

The fields in chiral region $a < \rho < b$ can be written as the combination of right and left circular polarized vector wave functions. The fields in chiral region are

$$\mathbf{E}_c = \sum_{n=-\infty}^{+\infty} j^{-n} \left[c_n \mathbf{E}_{R,n}^{(1)} + d_n \mathbf{E}_{L,n}^{(1)} + e_n \mathbf{E}_{R,n}^{(2)} + f_n \mathbf{E}_{L,n}^{(2)} \right]$$

$$\mathbf{H}_c = \frac{j}{\eta} \sum_{n=-\infty}^{+\infty} j^{-n} \left[c_n \mathbf{E}_{R,n}^{(1)} - d_n \mathbf{E}_{L,n}^{(1)} + e_n \mathbf{E}_{R,n}^{(2)} - f_n \mathbf{E}_{L,n}^{(2)} \right],$$

where subscripts o and c are used for the fields in free space and chiral region, respectively. In above expressions, a_n, b_n, c_n, d_n, e_n and f_n are unknown coefficients to be determined by applying the boundary conditions. The subscripts R, L are used to represent the right and left circularly polarized fields. These fields are obtained by the superposition of $\mathbf{M}_n$ and $\mathbf{N}_n$ vector wave functions and are expressed as [16]

$$\begin{aligned}\mathbf{E}_{R,n}^{(p)} &= \mathbf{M}_n^{(p)}(k_R) + \mathbf{N}_n^{(p)}(k_R)\\ \mathbf{E}_{L,n}^{(p)} &= \mathbf{M}_n^{(p)}(k_L) - \mathbf{N}_n^{(p)}(k_L).\end{aligned}$$

Now, the boundary conditions become,

$$\begin{aligned}\hat{n}\cdot\mathbf{D}_c &= 0, \qquad \rho = a, \quad 0 \le \phi \le 2\pi\\ \hat{n}\cdot\mathbf{B}_c &= 0, \qquad \rho = a, \quad 0 \le \phi \le 2\pi\\ [\mathbf{E}_0^{inc} + \mathbf{E}_0^{sca}]_t &= [E_c]_t, \quad \rho = b, \quad 0 \le \phi \le 2\pi\\ [\mathbf{H}_0^{inc} + \mathbf{H}_0^{sca}]_t &= [H_c]_t, \quad \rho = b, \quad 0 \le \phi \le 2\pi\end{aligned}$$

where subscript t stands for tangential components of field. By using these boundary conditions the unknown coefficients are given below

$$\begin{aligned}a_n &= c_n\left[\frac{J_n(k_Rb)H_n^{(2)}(k_Ra) - J_n(k_Ra)H_n^{(2)}(k_Rb)}{H_n^{(2)}(k_Ra)H_n^{(2)}(k_ob)}\right]\\ &\quad -d_n\left[\frac{J_n(k_Lb)H_n^{(2)}(k_La) - J_n(k_La)H_n^{(2)}(k_Lb)}{H_n^{(2)}(k_La)H_n^{(2)}(k_ob)}\right] - \frac{J_n(k_ob)}{H_n^{(2)}(k_ob)}\\ b_n &= \frac{\eta_o}{\eta}\left[c_n\left(\frac{J_n(k_Rb)H_n^{(2)}(k_Ra) - J_n(k_Ra)H_n^{(2)}(k_Rb)}{H_n^{(2)}(k_Ra)H_n^{(2)}(k_ob)}\right)\right.\\ &\quad \left. + d_n\left(\frac{J_n(k_Lb)H_n^{(2)}(k_La) - J_n(k_La)H_n^{(2)}(k_Lb)}{H_n^{(2)}(k_La)H_n^{(2)}(k_ob)}\right)\right]\\ c_n &= \frac{\left(\frac{\eta_o}{\eta}A_L - A'_L\right)X_n}{\left(\frac{\eta_o}{\eta}A_R - A'_R\right)\left(A_L - \frac{\eta_o}{\eta}A'_L\right) + \left(\frac{\eta_o}{\eta}A_L - A'_L\right)\left(A_R - \frac{\eta_o}{\eta}A'_R\right)}\\ d_n &= \frac{-\left(\frac{\eta_o}{\eta}A_R - A'_R\right)X_n}{\left(\frac{\eta_o}{\eta}A_L - A'_L\right)\left(A_R - \frac{\eta_o}{\eta}A'_R\right) + \left(\frac{\eta_o}{\eta}A_R - A'_R\right)\left(A_L - \frac{\eta_o}{\eta}A'_L\right)}\end{aligned}$$

In previous equations,

$$X_n = \frac{J_n(k_ob){H'}_n^{(2)}(k_ob) - {J'}_n(k_ob)H_n^{(2)}(k_ob)}{H_n^{(2)}(k_ob){H'}_n^{(2)}(k_ob)}$$

$$A_s = \frac{J_n(k_sb)H_n^{(2)}(k_sa) - J_n(k_sa)H_n^{(2)}(k_sb)}{H_n^{(2)}(k_sa)H_n^{(2)}(k_ob)} \tag{11a}$$

$$A'_s = \frac{{J'}_n(k_sb){H'}_n^{(2)}(k_sa) - {J'}_n(k_sa){H'}_n^{(2)}(k_sb)}{{H'}_n^{(2)}(k_sa){H'}_n^{(2)}(k_ob)} \tag{11b}$$

where subscript s could be either R or L, and the relation between coefficients e_n, c_n and f_n, d_n is as follows

$$e_n = -\frac{J_n(k_R a)}{H_n^{(2)}(k_R a)} c_n \quad f_n = -\frac{J_n(k_L a)}{H_n^{(2)}(k_L a)} d_n.$$

Now, we discuss the same problem as in Figure 2, but here the coating material is chiral nihility metamaterial instead of chiral metamaterial. The constitutive relations and wavenumbers for chiral nihility medium are given by (8) and (9), respectively. The corresponding unknown coefficients become

$$\begin{aligned}
a_n &= c_n \left[\frac{J_n(k_R b)H_n^{(2)}(k_R a) - J_n(k_R a)H_n^{(2)}(k_R b)}{H_n^{(2)}(k_R a)H_n^{(2)}(k_o b)}\right] \\
&\quad - d_n \left[\frac{J_n(k_L b)H_n^{(2)}(k_L a) - J_n(k_L a)H_n^{(2)}(k_L b)}{H_n^{(2)}(k_L a)H_n^{(2)}(k_o b)}\right] - \frac{J_n(k_o b)}{H_n^{(2)}(k_o b)} \\
b_n &= \frac{\eta_o}{\eta}\left[c_n \left(\frac{J_n(k_R b)H_n^{(2)}(k_R a) - J_n(k_R a)H_n^{(2)}(k_R b)}{H_n^{(2)}(k_R a)H_n^{(2)}(k_o b)}\right)\right. \\
&\quad \left. + \, d_n \left(\frac{J_n(k_L b)H_n^{(2)}(k_L a) - J_n(k_L a)H_n^{(2)}(k_L b)}{H_n^{(2)}(k_L a)H_n^{(2)}(k_o b)}\right)\right] \\
c_n &= \frac{\left(\frac{\eta_o}{\eta}A_L - A'_L\right)X_n}{\left(\frac{\eta_o}{\eta}A_R - A'_R\right)\left(A_L - \frac{\eta_o}{\eta}A'_L\right) + \left(\frac{\eta_o}{\eta}A_L - A'_L\right)\left(A_R - \frac{\eta_o}{\eta}A'_R\right)} \\
d_n &= \frac{-\left(\frac{\eta_o}{\eta}A_R - A'_R\right)X_n}{\left(\frac{\eta_o}{\eta}A_L - A'_L\right)\left(A_R - \frac{\eta_o}{\eta}A'_R\right) + \left(\frac{\eta_o}{\eta}A_R - A'_R\right)\left(A_L - \frac{\eta_o}{\eta}A'_L\right)}
\end{aligned}$$

In above equations,

$$X_n = \frac{J_n(k_o b)H'^{(2)}_n(k_o b) - J'_n(k_o b)H_n^{(2)}(k_o b)}{H_n^{(2)}(k_o b)H'^{(2)}_n(k_o b)}$$

$$A_s = \frac{J_n(k_s b)H_n^{(2)}(k_s a) - J_n(k_s a)H_n^{(2)}(k_s b)}{H_n^{(2)}(k_s a)H_n^{(2)}(k_o b)} \tag{12a}$$

$$A'_s = \frac{J'_n(k_s b)H'^{(2)}_n(k_s a) - J'_n(k_s a)H'^{(2)}_n(k_s b)}{H'^{(2)}_n(k_s a)H'^{(2)}_n(k_o b)} \tag{12b}$$

where subscript s could be either R or L and the relation between coefficients e_n, c_n and f_n, d_n is as follows

$$e_n = -\frac{J_n(k_R a)}{H_n^{(2)}(k_R a)} c_n \quad f_n = -\frac{J_n(k_L a)}{H_n^{(2)}(k_L a)} d_n.$$

The above mentioned results reveal that there is no backward scattered wave in chiral nihility medium. Moreover, both co- and cross-polarized field components exist in scattered fields from chiral and chiral nihility coated DB cylinder.

The solution for TE^z polarized plane wave can be determined by using principle of duality.

5. NUMERICAL RESULTS AND DISCUSSION

In this section, plots are presented for co- and cross-polarized components of the fields scattered from chiral and chiral nihility coated circular DB cylinder. In this case, we have chosen $a = 0.5\lambda$, $b = 1.0\lambda$, $\lambda = 1\,\text{m}$, $\epsilon_c = 3$, $\mu_c = 2$ and comparison is given for different values of κ. In Figure 3 co-polarized components of field scattered by chiral coated DB core is given for different values of κ. Figure 4 shows the comparison of their cross-polarized field components. Co- and cross-polarized components of the scattered field are presented in Figures 5 and 6, when DB cylinder is coated by DNG chiral layer, i.e., $\epsilon_c = -3$, $\mu_c = -2$. Co- and cross components of field scattered by chiral nihility coated DB cylinder with different chirality parameter, are given in Figures 7 and 8. The difference in co- and cross-polarized components of field scattered from coated DB core is obvious from the figures.

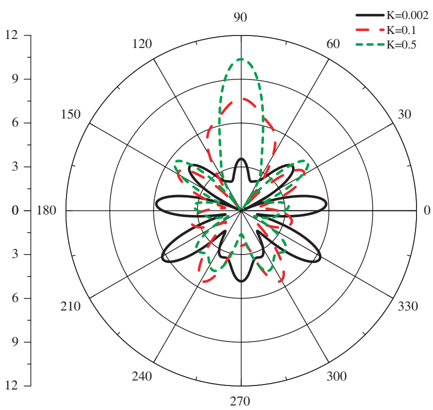

Figure 3. Co-pol. components of scattering cross-section of chiral-coated DB core.

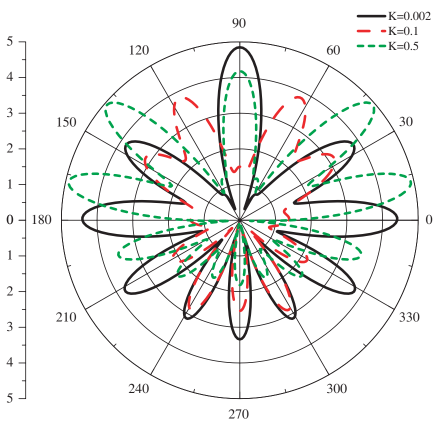

Figure 4. Cross-pol. components of scattering cross-section of chiral-coated DB core.

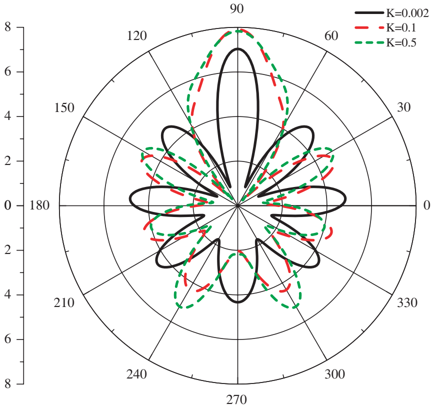

Figure 5. Co-pol. components of scattering cross-section of DNG chiral-coated DB core.

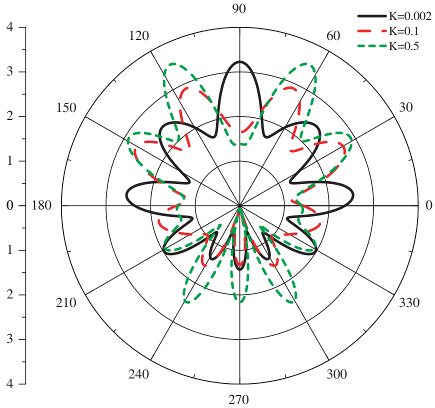

Figure 6. Cross-pol. components of scattering cross-section of DNG chiral-coated DB core.

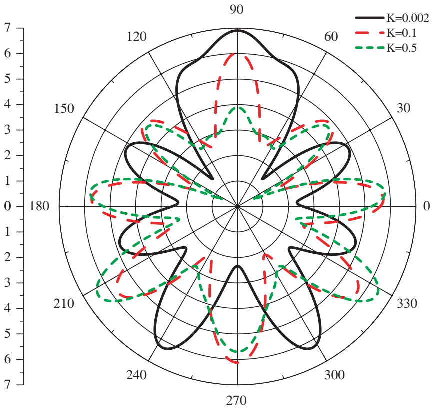

Figure 7. Co-pol. components of scattering cross-section of chiral nihility-coated DB core.

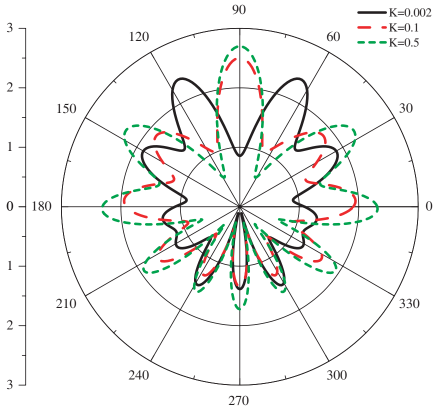

Figure 8. Cross-pol. components of scattering cross-section of chiral nihility-coated DB core.

6. CONCLUSIONS

Scattering from a circular coated/uncoated DB cylinder placed in free space/chiral/chiral nihility metamaterial is analyzed. It is found that DB cylinder placed in free space behaves as PEC surface for TM^z polarized incident wave with respect to axis (z-axis) of the cylinder and behaving as PMC for TE^z polarized incident wave. On the other hand, the DB cylinder placed in chiral and chiral nihility metamaterial acts as a perfect scatterer, and there is no backward scattered wave in chiral nihility medium. In case of chiral and chiral nihility coating of DB cylinder, it is found that both co- and cross-components appear in scattered fields. The numerically results verify the presence of co- and cross-components of fields.

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