RECEIVING ANTENNAS EMBEDDED WITHIN NONRECIPROCAL MAGNETIC PHOTONIC CRYSTALS

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A new class of magnetic photonic crystals (MPCs) constructed from periodic arrangements of readily available anisotropic layers was recently introduced (A. Figotin and I. Vitebsky, "Nonreciprocal magnetic photonic crystals," Physical Review E, vol. 63, pp. 117, May 2001). Initial analytical studies of these in a semi–infinite model demonstrated that they exhibit phenomena of drastic incoming wave slow–down and concurrent amplitude growth while maintaining a minimal reflection at the boundary (A. Figotin and I. Vitebsky, "Electromagnetic unidirectionality in magnetic photonic crystals," Physical Review B, vol. 67, pp. 120, Apr. 2003). These phenomena are a consequence of the frozen modes realized at specific frequencies where a stationary inflection point exists within the band diagram. In a recent presentation (Mumcu et. al., "RF propagation in finite thickness nonreciprocal magnetic photonic crystals," IEEE APS Symposium 2004, vol. 2, pp. 1395-1398), we demonstrated a full wave characterization (amplitude growth, bandwidth, coupling and thickness required for maximum amplitude) of the phenomena for finite thickness MPCs. We demonstrated that for a practical MPC slab, the frozen mode phenomena can be indeed realized, and have promise in developing miniature antenna arrays embedded within the MPC.

In this paper, we consider the performance of a receiving antenna element within the MPC. We concentrate on the problem of a short dipole antenna placed within a finite thickness MPC. The current induced on the dipole due to an incident plane wave illumination is found via the spectral domain–method of moments (SP-MOM) approach. However, since the MPC consists of highly anisotropic dielectric and magnetically gyrotropic materials, the mathematics are rather complex. Our analysis specifically focuses on the frozen mode regime to investigate the effect of MPC on the receiving properties of the dipole antenna. Along with pattern shaping, the phenomenon of minimal reflection at the MPC boundary can be utilized for improving the gain.

We will present the analysis method along with representative results for radiating and receiving dipoles embedded within the crystal. We will also discuss the SD-MOM for anisotropic layered structure.

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: mumcu6997

Date Received: September 23, 2004

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2. B - Fields and Waves
3. (a) Special Session: Metamaterials And Other Complex Materials
4. I - Invited Paper, Program chair: Prof. Eleftheriades and Prof. Volakis
5. No special instructions