

METAMATERIAL-BASED REALIZATIONS OF EFFICIENT ELECTRICALLY SMALL ANTENNAS

Aycan Erentok, Richard W. Ziolkowski
ECE, University of Arizona

METAMATERIAL-BASED REALIZATIONS OF EFFICIENT ELECTRICALLY SMALL ANTENNAS

Aycan Erentok* and Richard W. Ziolkowski

Department of Electrical and Computer Engineering The University of Arizona 1230 E. Speedway Tucson, AZ 85721-0104 USA

Tel: (520) 621-6173 Fax: (520) 621-8076 E-mail: erentoka@ece.arizona.edu, ziolkowski@ece.arizona.edu

The possibility of an efficient electrically small antenna (EESA) was predicted recently by Kipple and Ziolkowski [IEEE Trans. Antennas Propagat., vol. 51, pp. 2626-2640, October 2003]. It consisted of an electrically small dipole antenna surrounded by an electrically small double negative (DNG) metamaterial shell. The DNG metamaterial was lossless. Reciprocity between the proposed EESA geometry and resonant scattering from spheres with DNG coatings has also been demonstrated by Kipple and Ziolkowski [IEEE Antennas and Propagation Society International Symposium and USNC/URSI National Radio Science Meeting, Session 91, Monterey, CA, June 20-26, 2004]. Furthermore, it was demonstrated that the EESA could be realized with only an epsilon-negative (ENG) metamaterial shell.

We will report further results for the EESA geometry. Predictions of the EESA sizes and performances at 10GHz and at 400 MHz will be presented. These will include determining the power gain of the EESA in the presence of a lossy DNG metamaterial shell. It is found that losses decrease the amplitude and broaden the resonance. However, significant enhancements are still realized. Variations in the index of refraction of the DNG shells have also been explored. Analogous studies have also been performed for the lossy ENG shell based EESA with similar conclusions. The ENG shell based EESA has also been designed with ANSOFT's High Frequency Structure Simulation (HFSS) tools. Results for these simulations will also be presented. The HFSS simulations have allowed us to explore the near-field and far-field operating characteristics of an electrically small dipole antenna in the presence of an ENG shell.

We are also investigating how one could realize the DNG and ENG metamaterial shells. We are considering the use of lumped element based artificial electric and magnetic molecules to achieve the desired metamaterial effects. Preliminary results from these studies will also be given.

Abstract Submission Form
2004 National Radio Science Meeting

Abstract: ziolkowski16037

Date Received: September 16, 2004

1. (a) Richard Ziolkowski
Department of Electrical and Computer Engineering
University of Arizona
1230 E. Speedway Blvd
Tucson, AZ
85721 USA
ziolkowski@ece.arizona.edu
- (b) 520 621 6173
- (c) 520 621 8076
2. B - Fields and Waves
3. (a) Metamaterials and Other Complex Materials
4. I - Invited Paper
5. Special Session Chairs:
George Eleftheriades, John Volakis