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Wide-band CEBG-based Directive Antenna

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Introduction

Recently, new periodic structures, Cylindrical Electromagnetic Band Gap (CEBG) structures, have been introduced and used as models to develop new directive antennas or new beam switching antennas [1-3]. These structures are radially and circularly periodic, and they present pass-band and stop-band to cylindrical electromagnetic waves. In [2], experimental results for a multi-band reconfigurable CEBG antenna have been presented, whereas in [3], an analysis of the transmission coefficient of CEBG structures and experimental results for a CEBG directive antenna with a 28% impedance bandwidth have been presented. In this paper, the design and experimental results for a new wide-band (78%) CEBG based-directive antenna are presented. This work was made under a project which consists on the design of an agile antenna for tactical communications in the band : 1.35 *GHz* - 2.7 *GHz*.

Description of the antenna

Using the Finite Difference Time Domain (FDTD) method, numerical simulations were carried out to obtain the design of the wide-band CEBG antenna. The top view and side view of the optimized antenna are shown in Figs. 1 and 2, respectively. It is composed of a dipole as the excitation source, two metallic cones and the CEBG structure with continuous and discontinuous wires.

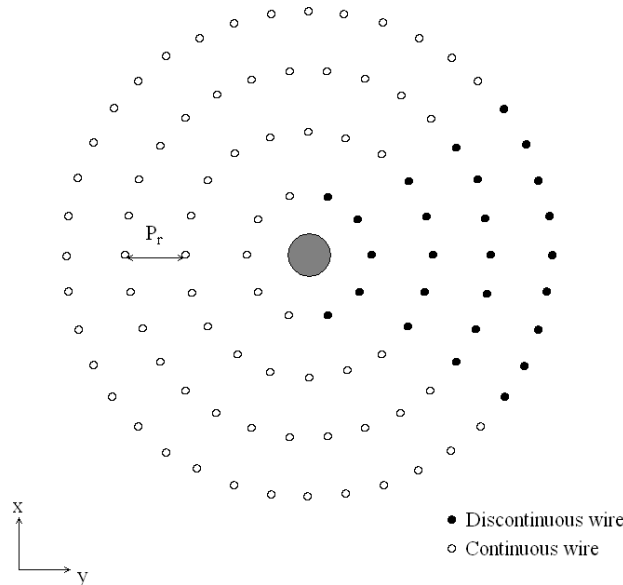


Figure 1: Top view of the proposed antenna : $P_r=39\text{mm}$.

The dipole is initially wide-band, but the CEBG structures modifies significantly the

matching of the antenna if it is not configured adequately. To ensure the impedance matching, the defect configuration is slightly modified compared to the horn-shape defect [3] : two other wires are set as discontinuous in the first cylindrical periodic surface. The distances between the dipole and the first cylindrical periodic surface, and between the dipole and the metallic cones should also be optimized. In addition, the angular period of the first layer should not be too small.

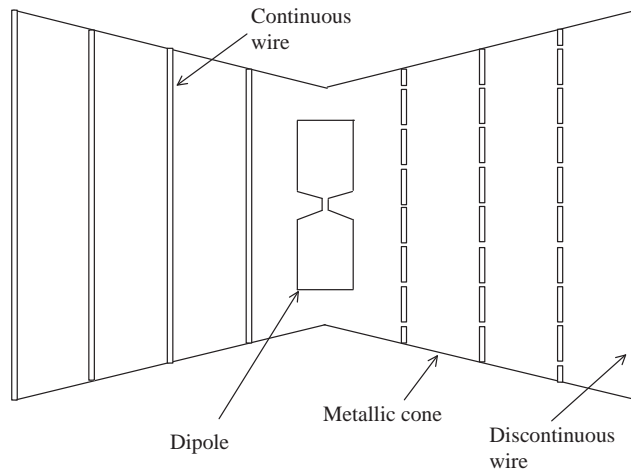


Figure 2: Side view of the antenna

Experimental Results

To validate our design, a prototype of the CEBG-antenna, where defects consist of removed wires, was fabricated. Fig. 3 shows photographs of the prototype.

Testing was conducted during the fabrication process to ensure expected performance at various stages. This involved testing the dipole alone and the CEBG-antenna. Fig. 4 shows the simulated and measured return losses of the CEBG antenna. From the measured curve, a bandwidth ($S_{11} < -10$ dB) from 1.19 GHz to 3 GHz is achieved. However directive beams are obtained only for frequencies equal or lower than 2.7 GHz. Thus, the bandwidth of the antenna is from 1.19 GHz to 2.7 GHz, which is enough to cover the band from 1.35 GHz to 2.7 GHz.

A further study of the antenna has focused on its radiation performance. The radiation patterns were measured in an anechoic chamber located at INRS, in Montreal. The measured patterns at 1.35 GHz and 2.7 GHz in the H-plane and E-plane are shown in Figs. 5 and 6, respectively. There is a slight difference between simulated and measured results due to defects of fabrication. The measured gain is between 8 and 13 dB.

Conclusion

In this work, a new CEBG-based directive antenna with a wide-band impedance bandwidth has been designed and fabricated. The obtained results show that the proposed antenna can offer a bandwidth of 78%. The measured gain is between 8 and 13 dB. To increase the gain, the number of cylindrical layers in the CEBG structure can be increased without modifying the impedance bandwidth significantly.

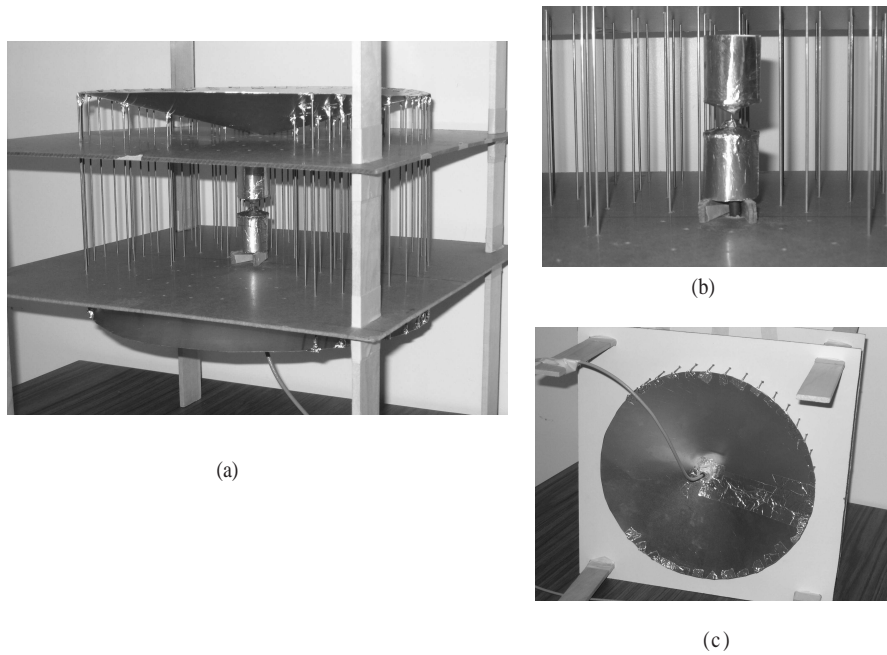


Figure 3: (a) Fabricated CEBG antenna. (b) Dipole : excitation source. (c) Feeding : coaxial line.

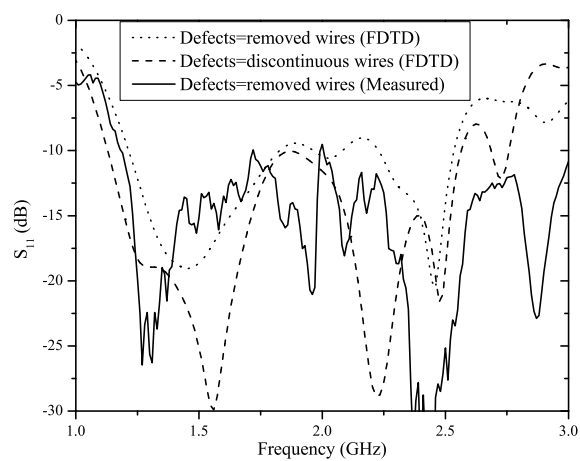


Figure 4: Measured and simulated return losses of the CEBG antenna.

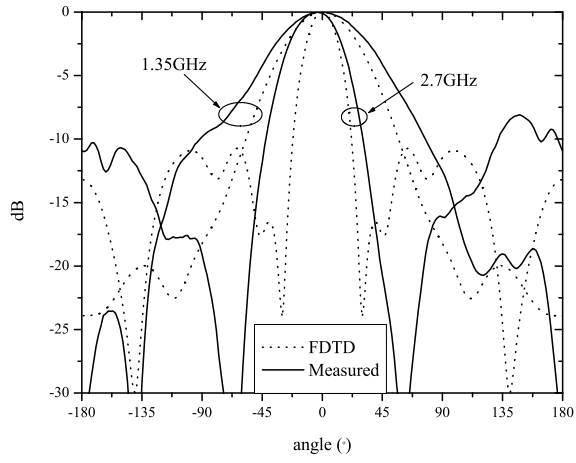


Figure 5: Measured and simulated radiation patterns in the H-plane at the limit frequencies.

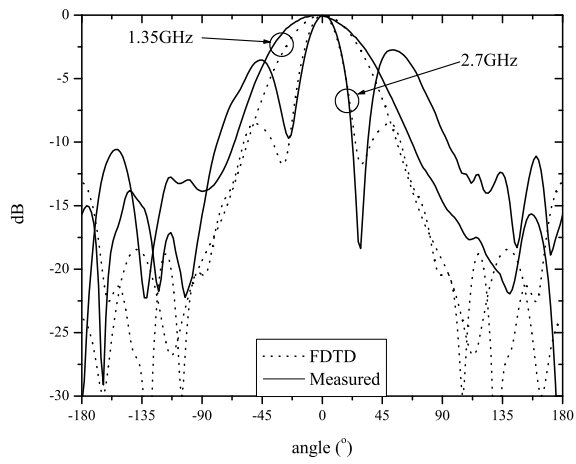


Figure 6: Measured and simulated radiation patterns in the E-plane at the limit frequencies.

Acknowledgment

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