

A Near-Field Enhancer for Electromagnetic Band Gap Resonator Antennas

Mohammad Nasrat Zaqumi ¹, Ali Lalbakhsh ²

¹ School of Engineering

Macquarie University, Sydney, Australia

mohammadnasrat.zaqumi@mq.edu.au,

² School of Engineering

Macquarie University, Sydney, Australia

ali.lalbachsh@mq.edu.au

It is revealed that electromagnetic band gap resonator antennas (EBG) have nonuniform near-field phase distributions [1], which negatively impact the far-field radiation patterns. Therefore, the near field phase rectification method has been theorized and proved using an all-dielectric phase transformation structure (PTS) for the EBG, but they are large profile and non-planar [1, 2, 3]. Thus, printed planar PTS has been prototyped as a substitution for the all-dielectric structures [4]; a 1D planar printed PTS was designed, which improved the general performance of the EBG similar to the all-dielectric structures. However, printed PTS consists of multiple dielectric substrates, adding to cost, high loss, and manufacturing complexity [5].

This paper proposes an efficient method for directivity enhancement of the EBG with enhancement of near-field phase distribution. A single dielectric layer PTS is designed on the operational frequency of 11 GHz of the EBG. PTS consists of different patterns of square and cross patches on both sides of the single dielectric layer to compensate for the phase error of near-field phase distribution of the EBG. The PTS is installed on the top of the EBG; hence, it improves near-field phase distribution uniformity, leading to the improvement of far-field directivity. Fig. 1 (a) illustrates the electric field distribution of the proposed antenna; it can be observed that the phase uniformity has doubled by 200% from 30 mm to 60 mm by considering the 45-degree variation from the center of the phase distribution as the uniformity. Furthermore, the impact of phase distribution can also be realized from the directivity improvement; there is a 5.5-dB enhancement from (9.5 to 15) db, as shown in Fig. 1 (b).

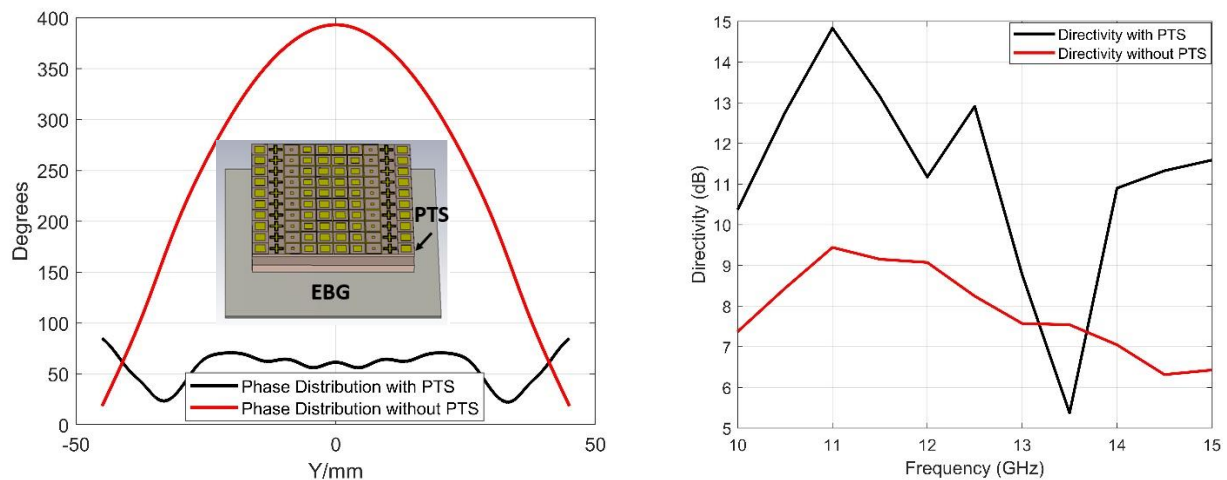


Fig. 1: 1D Phase transformation structure result: (a) phase distribution with and without PTS, (b) directivity versus frequency with and without PTS.

References

- [1] M. U. Afzal, K. P. Esselle, B. A. J. I. T. o. A. Zeb, and Propagation, "Dielectric phase-correcting structures for electromagnetic band gap resonator antennas," vol. 63, no. 8, pp. 3390-3399, 2015.
- [2] A. Lalbakhsh, M. U. Afzal, B. A. Zeb, and K. P. Esselle, "Design of a dielectric phase-correcting structure for an EBG resonator antenna using particle swarm optimization," in 2015 International Symposium on Antennas and Propagation (ISAP), 2015, pp. 1-3: IEEE.
- [3] A. Lalbakhsh, M. U. Afzal, K. P. J. I. A. Esselle, and W. P. Letters, "Multiobjective particle swarm optimization to design a time-delay equalizer metasurface for an electromagnetic band-gap resonator antenna," vol. 16, pp. 912-915, 2016.
- [4] A. Lalbakhsh and K. P. Esselle, "Directivity improvement of a Fabry-Perot cavity antenna by enhancing near field characteristic," in 2016 17th International Symposium on Antenna Technology and Applied Electromagnetics (ANTEM), 2016, pp. 1-2: IEEE.
- [5] D. Zhang and Y. Lu, "High Gain Antenna Based on Single-Layer High-Efficiency Transmitting Phase-Gradient Metasurface," in 2018 International Conference on Microwave and Millimeter Wave Technology (ICMMT), 2018, pp. 1-3: IEEE.