Embedded MTM-EBGs for Antenna Applications

Stuart Barth, Braden P. Smyth, Jacob A. Brown, and Ashwin K. Iyer*
University of Alberta, Faculty of Electrical and Computer Engineering
iyer@ece.ualberta.ca

Metamaterials (MTMs) and electromagnetic bandgap structures (EBGs) have seen increasing use in microwave engineering for miniaturization, multi-band operation, and other enabling functionalities. One recent technology known as the metamaterial-based electromagnetic bandgap structure (MTM-EBG) has proven particularly useful for integration into microstrip antennas and feed networks. The MTM-EBG is fully uniplanar and, once embedded into a microstrip device, can present a bandgap to parallel-plate-like and microstrip-like modes. Furthermore, the MTM-EBG can be realized using fully printed lumped elements, which simplifies fabrication and allows operation from microwave up to millimeter wave frequencies and beyond. The utility of the MTM-EBG is further established by the fact that its dispersion properties may be rigorously and accurately modeled using multiconductor transmission line (MTL) theory, allowing strategic and general design procedures to predict its behavior, which eliminates ad-hoc approaches and minimizes arbitrary tuning.

This talk will review the many examples of MTM-EBG usage in antennas and antenna systems that have been demonstrated in the recent literature (S. Barth and A. K. Iyer, 2017 IEEE APS, URSI-USNC Intl. Symp. Digest, pp. 1077-1078, and B. P. Smyth *et. al*, IEEE Trans. Antennas Propag., vol. 64, no. 12, pp. 5046-5053, Dec. 2016). Both rectangular and circular patch antennas have been made dual-band by embedding MTM-EBGs onto the radiating edges, with the resulting structure being more compact than single-band antennas at the lower operating frequency. Radiation properties of the dual-band antennas are comparable to conventional patches, for both linear and circular polarizations. The challenge of feeding these dual-band antennas has also been addressed with MTM-EBGs, as they have been integrated into impedance transformers, Wilkinson power dividers, and directional couplers for dual-band operation. These devices have been designed for various frequencies with different modes of operation, which further demonstrates the versatility of this approach. All of these structures serve to show that the MTM-EBG is suitable for a variety of antenna applications, and provides many advantages compared to other approaches.