Glide-symmetric holey metallic structures for cost-effective implementations of gap waveguide technology

Oscar Quevedo-Teruel(1), Mahsa Ebrahimpouri(1), Qingbi Liao(1), Astrid Algaba-Brazalez(2), Adrian Tamayo-Dominguez(3), Jose M. Fernandez-Gonzalez(3), Pablo Padilla(4), Zvonimir Sipus(5), and Eva Rajo-Iglesias(6)
(1) KTH Royal Institute of Technology SE-10044, Stockholm, Sweden.
(2) Ericsson AB, 417 56 Gothenburg, Sweden.
(3) Polytechnic University of Madrid, 28040 Madrid, Spain.
(4) University of Granada, 18071 Granada, Spain.
(5) University of Zagreb, 10000 Zagreb, Croatia.
(6) University Carlos III of Madrid, 28911 Leganes, Spain.

Gap waveguide technology has rapidly developed since its first implementation in 2009 (P.-S. Kildal, E. Alfonso, A. Valero-Nogueira, and E. Rajo-Iglesias, *IEEE Antennas and Wireless Propagation Letters*, 8, 84–87, 2009). The motivation of gap waveguide technology is straightforward. First, technologies based on dielectrics, such as microstrip technology, have unaffordable losses at high frequency. On the other hand, miniaturized fully-metallic waveguides are difficult to manufacture at those frequency ranges, thus raising their cost, especially if a large number of circuits and components are required in the front-end. Therefore, gap waveguide is a low-loss solution and it is easier to manufacture than conventional waveguides.

In gap waveguide technology, the electromagnetic waves propagate in air and are guided by surrounding metal (considering the groove and ridge versions). In the propagation area, a parallel plate (ridge) or a conventional waveguide (groove) are created with two independent layers (top and bottom). These propagation areas are surrondended by periodic structures that have electromagnetic bandgaps (EBGs) at the operational frequencies. These structures inhibit the leakage of the electromagnetic energy, so the electromagnetic waves are confined in the air – in the ridge or groove region. In the first proposals, bed-of-nails were employed as an EBG to confine the electromagnetic fields (P.-S. Kildal, A. Zaman, E. Rajo-Iglesias, E. Alfonso, and A. Valero-Nogueira, *IET Microwaves, Antennas and Propagation*, 5, 262-270, 2011).

Although the simplicity and high potential of the original idea, bed-of-nails proved to be difficult to manufacture at a low cost, especially for high frequencies. Recently, an alternative, based on glide-symmetric holes, was proposed to mitigate this limitation (M. Ebrahimpouri, O. Quevedo-Teruel, and E. Rajo-Iglesias, *IEEE Microwave and Wireless Components Letters*, 27,542-544, 2017). These holes have the advantage of presenting a smaller height and larger periodicity than bed-of-nails. Recent works have demonstrated the potential of glide-symmetric holes for conventional waveguides, phase shifters and mode converters. Moreover, their simplicity is ideal for flanges or transitions between components and circuits. Most recently, it has been demonstrated that their symmetry properties can also be slightly broken to create integrated filters. Finally, they have advantageous conditions for reconfigurable implementations with liquid crystals.

In the conference presentation, we will introduce the concept of glide symmetry and its application to gap waveguide. Afterwards, we will summarize some design guidelines, and the advantages and drawbacks with respect to bed-of-nails realization supported by measured results.