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Progress Report on Developing Metamaterial EBG-based Gap Waveguide Components and Packaging Solutions between 1 GHz and several 100 GHz

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Recently a new gap waveguide technology for millimeter and submillimeter waves have been introduced (P.-S. Kildal, E. Alfonso, A. Valero-Nogueira, E. Rajo-Iglesias, "Local metamaterial-based waveguides in gaps between parallel metal plates", Antennas and Wireless Propagation letters (AWPL), Volume 8, pp. 84-87, 2009). The waveguide is generated in a narrow gap between parallel metal plates, one of which is textured by a periodic EBG-type pattern that prevents global parallel plate modes to propagate, and in between this pattern there are metal ridges or strips or grooves forming the waveguide along which local waves propagate. The advantages relative to other types of transmission lines like microstrip lines and cylindrical waveguides are that the gap waveguides can be realized without dielectric, and there is no need for any metal connection between the two plates, although there may with advantage be a metal rim along the edges of the plates to support them at a constant height relative to each other. The last two years the feasibility of the new waveguide has been studied and published (P.-S. Kildal, A. Uz Zaman, E. Rajo-Iglesias, E. Alfonso, A. Valero-Nogueira, "Design and experimental verification of ridge gap waveguides in bed of nails for parallel plate mode suppression", accepted for publication in IET Microwaves, Antennas & Propagation, September 2010.)

The simplest realizations of the EBG texture are metal pins that easily can be casted or milled, like the ridges also can be. Such manufacturing will also allow the height of the texture to vary, thereby creating more opportunities and degrees of freedom in a design process than normal microstrip lines. This may open up for new solutions for antennas and waveguide components. Of special interest is the integration of active components like filters and amplifiers in the geometry, which should be easy, because cooling, shielding and packaging are more or less automatically provided by the waveguide itself. A special challenge is to be able to measure performance when active and passive and radiating components are so closely integrated. It will not be possible to access intermediate ports. The gap waveguides support single quasi-TEM waves over at least an octave bandwidth, so they are very wideband with losses comparable with those of normal rectangular waveguides.

The present paper will give an overview of the work that has been done during the last year related to designing alternative textures that can provide stopbands for low frequency (below 5 GHz), micromachining of texture that can be used above 100 GHz, designing critical components such as calibration kit, transitions to rectangular waveguide and coaxial lines, microwave filters in ridge gap waveguide and groove gap waveguide structures, packaging of microstrip filters with gap waveguide structures showing improved performance, packaging of MMICs around 100 GHz, and antennas.

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