Multipolar Terahertz Antennas

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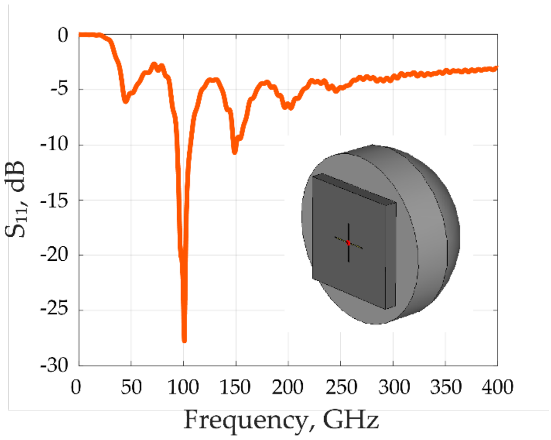
The recent progress on THz communications accelerated by photonic technologies [1] leads to a possible integration of THz devices in the next-generation communication systems (6G). However, as photonic-based Continuous-Wave (CW) THz sources are concerned, the output power is limited [2] and the coherence (spatial, temporal and polarization) is not sufficient to ensure sufficient signal-to-noise at reception for successful high-data-rate communications. Among the possible coherent sources, we proposed the use of a Dual-Frequency Vertical-external-Cavity Surface-Emitting Laser (DF-VeCSEL) based on the coexistence of two transverse modes operating around 1064 nm [3]. We demonstrated coherent and tunable THz emission using two kinds of photomixers, either a commercial Uni-Travelling Carrier Photodiode (UTC-PD) [4] or a plasmonic-based photoconductive antenna (PCA) [5]. In this work, we propose a solution to improve the THz output power by taking advantage of the transverse structuration of the laser modes. The idea is to collect all the optical beating spots available in the transverse Laguerre-Gauss modes of the DF-VeCSEL. To this end, we designed MultiPolar Antennas (MPA) at 100 GHz as a proof-of-concept. Fig. 1 shows the design of 2 crossed dipoles on a high-resistivity Si-lens, showing that impedance matching can be achieved (left) and that a higher gain is obtained in comparison to standard dipole antennas (right). We will discuss the possible compromises in terms of impedance matching, gain and bandwidth of different kinds of multipolar antenna designs using 2 to 4 dipoles, for various possible excitation polarity patterns.



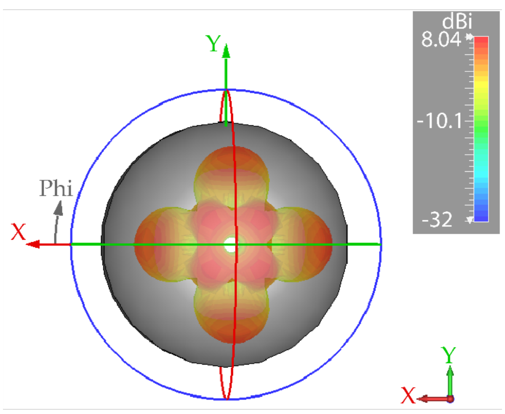


Figure 1: Multipolar antenna based on 2 crossed dipoles designed at 100 GHz.
Left) S_{11} parameter (Inset: view of the MPA). Right) Far-field pattern (max. realiz. gain of 8 dBi).

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