A Comparison of Measured and Computed Data for Photoconductive Antennas

John C. Young* [1], Darren Boyd [1], Stephen D. Gedney[1], Jinjun Liu[2], and Takehito Suzuki [3]

(1) University of Kentucky, Lexington, KY, 40506, USA
(2) University of Louisville, Louisville, KY, 40292, USA
(3) Ibaraki University, Hitachi, Ibaraki, 316-8511, Japan

The ever increasing push to higher frequency and wider bandwidth systems has now reached the terahertz band. One of the formidable challenges in terahertz band-system design is the generation and detection of terahertz waves. Currently, the most widespread antenna type used in terahertz systems is the photoconductive antenna which comprises biased metallic traces deposited on a photoconductive substrate. The antenna is usually excited using a pulsed laser to generate charge carriers in the photoconductive substrate which are accelerated onto the metallic traces by the voltage bias. Unlike most lower-frequency antenna analysis, the analysis of a photoconductive antenna requires the simultaneous solution of both Maxwell's equations and the semiconductor equations, which makes it a true multi-physics analysis. Since pulsed lasers excite relatively broadband waves, the analysis is more suited to time-domain solutions such as the Finite-Difference Time-Domain method (E. Sano and T. Shibata, IEEE T-APS, 372-377, 1990) or the Discontinuous-Galerkin Finite-Element Time-Domain (DGFETD) method (J. Young et. al, IEEE APS/URSI Symposium, #152.2, 2012).

Due to the difficulty of accurately modeling the different parts of the antenna, the electromagnetically large nature of the structure, as well as de-embedding the various system effects in the measured data, most measured and computed data reported in the literature have had a relatively large discrepancy. In this paper, measured and computed data for a variety of photoconductive antennas are reported. The DGFETD method is used to analyze the photoconductive antennas. The experimental antennas are fabricated on a thin LTG-GaAs layer deposited on a SI-GaAs substrate, and the antennas are excited using a pulsed femtosecond laser source. The antenna types include double-sided dipole, single-sided dipole, and bowtie antennas with various feed line configurations.