INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Analytical and Simulation Modeling of the Terahertz Photoconductive Antennas

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SHORT ABSTRACT

This research deals with the various aspects of the modeling of the Photoconductive Antennas (PCAs). The PCAs are used to radiate the Terahertz (THz) waves. This research work presents the simulation and the theoretical modeling of the PCAs. The simulation studies have been performed using Technology Computer Aided Design (TCAD). For this purpose, Sentaurus from Synopsys has been used. The simulation based modeling of the current pulse in a PCA has been done taking into account the underlying semiconductor device physics as well as the carrier transport dependencies on the different parameters such as the applied electric field, the defect concentrations, and their energy levels.

An improved equivalent electrical circuit model of the PCA working as the THz source has been proposed incorporating the basic semiconductor physics. In this work, a novel approach has been adopted to develop an equation for estimating the capacitance of the PCA. The presented circuit model is capable in predicting the effect of the different physical parameters on the performance of the PCA. The proposed model has been validated by simulation studies and available experimental results. Furthermore, a novel equivalent electrical circuit model of the PCA working as the THz receiver is also proposed. To compute the values of the circuit parameters, the same computation strategies have been adopted as proposed in the PCA source modeling.

This thesis also examines extensively the effect of the radiated near-zone fields on the PCA performance, an issue which was not adequately addressed in the earlier literature. Moreover, this thesis proposes a novel method for improving the radiated power from a PCA through the use of an external magnetic field. Furthermore, the analytical formulation of the radiated fields relating different PCA parameters is another topic which literature does not address adequately and in this thesis an attempt has been made to bridge this gap with the help of an improved semiconductor carrier dynamics.