INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Exploring the near field coupling and ultrafast switching in terahertz metamaterials

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SHORT ABSTRACT

During the last two decades, terahertz (THz) metamaterials (MMs) have emerged as one of the fascinating areas in photonics research because of their significance in developing devices for the THz gap. In this thesis work, the focus has been made in investigating the potential of planar two dimensional MMs structures which can be helpful in the design and construction of THz devices, such as switches, modulators, frequency tunable devices, antennas, etc. In this thesis work, in first problem, we have demonstrated a planar edge coupled MM structure to study the near field inductive coupling in THz MM. In this work, we report the tuning of electromagnetically coupled resonances in planar THz metamaterials by employing near field interactions via shifting the position of a resonator with respect to the other within the unit cell of the metamaterial. In addition, to study the near field inductive coupling in bilayer THz metamaterials, we also demonstrated a broadside coupled THz metamaterial structure. This structure contains two orthogonally placed SRRs separated by a thin micron-scale polyimide layer. In this case, we studied the THz transmission by displacing the top resonator w.r.t. the bottom resonator both in the horizontal and vertical directions. The THz transmissions through the proposed configurations result in the resonance mode hybridization effect due to the coupling between two different resonance modes. In addition, to improve the performance of the device in terms of Q-factor, we experimentally studied near field capacitive coupling in planar THz metamaterials. The unit cell of metamaterial comprises of two coupled SRRs with the split gaps facing each other. The coupling between two SRRs is examined by changing the gap of one resonator with respect to the other for various inter resonator separations. The measured THz transmission shows resonance mode hybridization. Further, to make active devices for THz gap, we demonstrated ultrafast switching in terahertz metamaterials by taking single SRR as a unit cell in a metamaterial and keeping the radiation damaged Silicon Island at the SRR gaps. Before optical excitation, because of the dielectric nature of the SRR gap, transmission through the sample gives rise to strong fundamental LC resonance. After optical excitation, the SRR gap loses dielectric nature and starts to conduct because of the excitation of the electron hole pairs. The change of fundamental resonance from the ON-to-OFF state is observed on a time scale of 4 picoseconds and then fast retrieval of the fundamental resonance to the ON-state within the next 20 ps.