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Resonance Broadening in Concentric Coupled Resonators based Metamaterials

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Metamaterials have demonstrated tremendous potential in applications such as sensing, polarization conversion [1], electromagnetic wave modulation [2] and cloaking etc. particularly in relatively unexplored terahertz region lying between microwave and infrared domains. Split ring resonators build the lattice of metamaterials. These artificial inclusions have the flexibility to manipulate the electromagnetic radiations as per desire by controlling the phase, amplitude and frequency. These can lead to enormous applications starting from high resolution imaging, ultrafast communication to detectors etc. Recent decades have witnessed enormous advancements in probing several physical phenomena like electromagnetically induced transparency, chirality and mode hybridization [3] and near field coupling [4] etc. In spite of above mentioned progresses, exploration of broadband features inherent in metamaterials requires more in-depth attention. Here in this work, we present a planar configuration of terahertz metamaterials exhibiting the broadband effect. The proposed design consists of a pair of concentric resonators. The inner is a closed meta-resonator while geometry of the outer resonator consists of double symmetric split gaps. This has resulted in several metamaterials samples with split gaps ranging from 0 μm (effectively closed ring) to 34 μm. With incident terahertz radiations having propagation vector perpendicular to the plane of metamaterial structure and direction of electric field polarization perpendicular to the split gaps, we find a blue shift as well as broadening of resonances in transmission spectrum measured experimentally with the help of terahertz time domain spectroscopy (THz-TDS), which has been validated further employing numerical simulator (CST MICROWAVE STUDIO). Redistribution of dipole resonant modes along with reduction in effective inductance of meta-structure are claimed to be the responsible factors for the observed results. Our metamaterial design has demonstrated its ability to realize the next generation terahertz devices operating in broader frequency range.

References

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