Characterization of a Terahertz Metamaterial Waveguide Plus the Development of Composite Right/Left-Handed Devices

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In order to meet the future demands of computation and communication, new approaches are needed to increase data operating speeds to the terahertz (THz) frequency range. To accomplish this goal, numerous device technologies capable of operating under these conditions need to be developed. The simplest device is an interconnect (e.g. a waveguide) that has low loss propagation of THz radiation between two points. Over the last decade, a number of different waveguide architectures have been studied. While the results are interesting, these devices are often characterized by high loss or the inability to extend their capabilities to higher functionality. In the work described here, I propose a novel THz waveguide geometry that not only allows for low loss propagation, but also exhibits a negative refractive index (NIR). This idea has been validated using both numerical simulations and experimental work. The numerical simulations were performed using xFDTD 6.3 (Remcom Inc.) and CST Microwave Studio, while the experimental work was carried out with an ultrafast laser-based THz time-domain spectrometer. The devices were fabricated using both 3D printing and a sacrificial layer methodology. Overall, I demonstrated the possibility of using split ring resonators as THz waveguides and characterized the presence of a NIR. Additionally, the work also developed complex composite right/left-handed Y-Splitters. The results indicate that for both device implementations there is a tight lateral and vertical confinement and a long propagation length. In earlier work using these structures, demonstrations including superlenses, cloaking fields, and applications in imaging have been shown. I expect that new opportunities will arise from the current work in guided-wave implementations.

Awards Won: