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Theory, Simulation and Experimental Characterization of Electromagnetic Metamaterials at Terahertz Frequencies

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Summary

Metamaterials have been utilized to create materials with unprecedented properties such as invisibility cloaks, negative refraction, and perfect lenses. However, metamaterials alone suffer important drawbacks - the resonant nature of most metamaterial designs to date results in significant frequency dispersion resulting in narrow bandwidth and large material absorption. The narrow band resonant response and large metamaterial absorption are arguably their greatest deficiencies and severely restricts many potential applications. We describe a?ohybrid metamaterialsa??, that form when the properties of a natural material - such as the dynamic photoconductivity of a semiconductor - strongly couples with the resonance of a metamaterial element. The resulting hybrid material will have passive properties that can be selected by the controlled design and patterning of the metamaterial elements, and dynamic properties that result from strategic incorporation of natural materials. Metamaterials thus not only extend and complement natural material response, they can also yield tunable properties enabling them to actively and individually control electric and magnetic fields. Coupled with their ability to yield nearly any electromagnetic response from RFs to near optical frequencies underscores their importance and substantiates their use for future state of the art devices operating in any technologically relevant spectral range.