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Electrically Controllable Molecularization of Terahertz Meta-Atoms

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Abstract

Active control of metamaterial properties is critical for advanced terahertz (THz) applications. However, the tunability of THz properties, such as the resonance frequency and phase of the wave, remains challenging. Here, a new device design is provided for extensively tuning the resonance properties of THz metamaterials. Unlike previous approaches, the design is intended to control the electrical interconnections between the metallic unit structures of metamaterials. This strategy is referred to as the molecularization of the meta-atoms and is accomplished by placing graphene bridges between the metallic unit structures whose conductivity is modulated by an electrolyte gating. Because of the scalable nature of the molecularization, the resonance frequency of the terahertz metamaterials can be tuned as a function of the number of meta-atoms constituting a unit metamolecule. At the same time, the voltage-controlled molecularization allows delicate control over the phase shift of the transmitted THz, without changing the high transmission of the materials significantly.

Keywords: graphene; ion gels; metamaterials; molecularization; terahertz.

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