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Near field coupled Metamaterials for Terahertz Wavelengths

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Active, passive and ultrafast modulations of subwavelength resonances in metamaterials through optical pump terahertz probe (OPTP) spectroscopy will be described in this talk. Particularly, reconfigurable resonance modes in metamaterials were demonstrated through switching from split-ring resonators to closed-ring resonators configurations via selective optical excitation of the split gap of ring resonator constituting the metamaterial unit cell. We observed that both the fundamental and the third-order resonance modes experienced monotonic damping because of increasing conductive losses in the photo-doped split gap region [**1**]. We have further observed the evolution of the second-order resonance mode by increasing the optical pump at very high value, which is otherwise forbidden in a split-ring resonator for the particular polarization of the incident probe beam. In another experiment we have shown ultrafast modulation of near field coupling between bright and dark resonance modes in metamaterials [**2**]. Such metamaterial unit cell consists of a pair of orthogonally twisted split ring resonators (bright and dark resonator) tightly bound through the induced near field electromagnetic lines. We placed ion implanted silicon layer with ultrafast carrier lifetime inside the dark resonator split gap to achieve active control of its resonance modes that determines the near field coupling inside the unit cell. Our experiments reveal ultrafast dynamical transition of near field coupling between bright and dark resonators allowing the metamaterial unit cell to change its state from coupled to decoupled, and eventually back to the coupled state. The intriguing features of all the measurements were further validated through extensive numerical calculations and explained in terms of appropriate physical models. These experimental realizations offer additional degrees of freedom in tuning the electromagnetic response of metamaterials.

References:

3. Dibakar Roy Chowdhury, Ranjan Singh, John F. O'Hara, Hou-Tong Chen, Antoinette J. Taylor and Abul K. Azad, *Applied Physics Letters*, **99**, 231101 (2011).
2. Dibakar Roy Chowdhury, Ranjan Singh, Hou-Tong Chen, Antoinette J. Taylor and Abul K. Azad, *Applied Physics Letters*, **102**, 011122 (2013).