TSF15-2015-000198

Abstract for an Invited Paper
for the TSF15 Meeting of
the American Physical Society

Bringing Nanoscale Matter to Life: Electrically Tunable Metamaterials and Metasurfaces for Control of Absorption, Emission and Scattering

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Progress in understanding resonant subwavelength optical structures has fueled a worldwide explosion of interest in both fundamental processes and nanophotonic devices for imaging, sensing, solar energy conversion and thermal radiation control. For most nanophotonic materials, the optical properties are encoded and fixed permanently into the nanoscale structure at the time of fabrication. Achieving electronic tunability of the optical properties is an emerging opportunity to bring metamaterials and metasurfaces to life as dynamic objects composed of tunable nanoscale resonators and antennas. Gated field effect tuning of the carrier density in conducting oxides and two-dimensional materials enables the optical dispersion of individual structures to be altered from dielectric to plasmonic, yielding active nano-antenna arrays with electrically tunable absorption, radiative emission and scattering properties.