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Active Conducting Oxide Plasmonics and Metasurfaces

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Plasmonic and metasurface structures have been extensively investigated in the last decade, the electromagnetic responses of those structures are usually fixed at the time of fabrication. In addition, current plasmonic and metasurface systems encounter high optical loss due to the electronic transition absorption of metal. In this talk, I will discuss the use of alternative plasmonic materials, i.e., transparent conducting oxides, to actively electrical control the optical properties of plasmonic and metasurface structures for studying new optical physics and advanced applications. This approach combines the advantages of i) the large optical tunability of conducting oxide materials, ii) the field-effect dynamics of MOS transistor, and iii) the high field confinement to achieve tunable plasmonics and metasurfaces. I will present an experimental demonstration of an ultracompact PlasMOStor, a plasmon slot waveguide field-effect modulator based on a conducting oxide active region that can modulate plasmonic signal with high dynamic range (2.71 dB/μm) and low waveguide loss ($\sim$0.45 dB/μm). In addition, I will present our recent results on gate-tunable metasurface that enables dynamic electrical control of the phase and amplitude of the light reflected from the metasurface. A phase shift of π and ˜30% change in the reflectance are achieved by applying 2.5 V gate bias, a basic requirement for electrically tunable beam-steering phased array metasurfaces.