Active Nanoplasmonics: Loss, Gain and Nonlinearity

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Active and tuneable plasmonic components are required for development of integrated photonic circuits, in high-density data storage applications as well as bio- and chemical sensing in lab-on-a-chip systems, to name a few. Plasmonic crystals, waveguiding components and metamaterials have recently been demonstrated to enhance various active functionalities based on electric, magnetic, acoustic and optical control signals. Amplification of plasmonic signals and dispersion management have also been addressed. All-optical control is especially interesting as it allows achievement of fast response and variety of approaches to be used, including nonlinear response and spontaneous and stimulated emission effects [1]. Other important prospective applications rely on the enhanced nonlinear magneto-optical effects. In this talk, we will overview new opportunities provided by plasmonic nanostructures for controlling photonic signals using the effects enabled by sub-wavelength field confinement and interaction between plasmonic resonances [2-16]. In addition to conventional intensity and phase modulations, active control of light polarization presents an important alternative. In turn, the polarization can be used as a control and condition the signal. The role of electron and phonon temperature effects will be discussed on the optical response of the nanostructures and it will be shown that their influence depends on the type of coupling between the plasmonic resonances. We will also discuss nonlinearities originating from free electrons in a metal in specifically tailored nanostructures to enhance second- and third- order nonlinearities [2-5]. We will show how to go beyond the brute-force field enhancement effects to achieve the enhanced nonlinear optical response due to the nonlocal properties of the assembly of interacting nanopartcicles. The loss/gain-induced coupling of plasmonic resonances will also be considered in non-Hermitian metamaterials, and its role in controlling polarization of transmitted/reflected light will be shown [15,16].

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