Polarization and Modal Degrees of Freedom for Tight Confinement of Light

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Abstract: We describe our work on tight confinement of light using plasmonic structures. Polarization and modal degrees of freedom are shown to have a crucial effect on the nanoscale focusing properties of the optical field.

OCIS codes: (260.5430) Polarization; (240.6680) Surface plasmons.

Following the ongoing effort for miniaturization of devices and systems, the capability for tight confinement of light is becoming a key for various applications ranging from lithography and optical storage to microscopy, light sources, nonlinear optics and biology. It was recently shown that the spot size obtained at the focal plane of a high numerical aperture lens can be significantly reduced if radially polarized illumination is used. In this talk we show the importance of radially polarized light in achieving tight focusing with plasmonic lenses. Several lens configurations are discussed including circular and elliptical geometries, as well as top and bottom grating structures. We discuss optimal parameters of the lens for focusing and radiation conditions.

In parallel, we explore approaches for nanoscale confinement of light on chip. We show that the 1-D equivalent of the radially polarized light, namely an anti-symmetric mode is of crucial importance for achieving tight confinement of light at the apex of a metallic tip. We demonstrate the tight confinement of light at the apex of a planar tip that is coupled to a silicon waveguide, supporting an anti-symmetric mode. Large energy density is observed at the tip apex, paving the way for using this platform for enhancing light matter interactions.