EIPBN Abstract

The recent invention of single metallic optical nanoantennas has greatly improved the mismatch between light and nanometer-scale objects. Optical nanoantennas are specifically engineered to enhance fields at visible and near-infrared (NIR) wavelengths and confine them to nanoscale regions in size, significantly defeating conventional diffraction-limited photon localization (~ 300 nm). Because metals no longer behave as “ideal” conductors at optical frequencies, optical nanoantennas are not simply “scaled-down” versions of radio antennas but are nanostructures that exploit the plasmon resonance in metals so as to achieve optimum interaction with optical fields. In a metal, plasmons oscillate at optical frequencies, but can have wavelengths comparable to x-rays (i.e. - very large k-vectors). By *efficiently* coupling light with localized plasmon modes, optical nanoantennas harness these short wavelength excitations to create extremely intense, ultra-confined optical fields. Using two-photon-excited photoluminescence of Au, intensity enhancements $> 10^3$ have been experimentally determined for Au bowtie nanoantennas with 20 nm gaps, in good agreement with theoretical simulations. These measurements of nanoantenna EM enhancements have recently led to the use of single Au bowties as calibrated on-chip surface-enhanced Raman scattering (**SERS**) sensors. In addition, the strong, localized fields have been utilized for fabrication purposes, resulting in the production of polymer resist nanostructures < 30 nm in diameter via nonlinear photopolymerization. The position, size, and shape of the resist nanostructures directly correlate with rigorous FDTD computations of the field distribution, providing a nanometer-scale measurement of the actual field confinement offered by single optical nanoantennas, as well as information on photoacid diffusion and resist resolution in SU-8.