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Surface plasmon mediated imaging at the nanoscale using metal lenses

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It has been proposed that a thin metal film can act as a near-field lens with sub-diffraction limit resolution. Near-field focusing with such metal lenses relies on the excitation of localized surface plasmons on a metal-dielectric interface in close proximity to a nanoscale light source. These plasmonic-lenses could have applications in near-field lithography and optical data storage. This presenation will focus on near-field scanning optical microscopy (NSOM) experiments that directly demonstrate frequency-dependent near-field focusing with planar metal films. In these studies the lens structure consists of a free-standing bilayer of 50nm Au and 50nm Si_3N_4, while the nanoscale object is formed by the tip of a near-field scanning optical microscope. The corresponding image behind the metal lens is detected via a Pt nanoparticle that acts as a near-field scatterer. We will show that low frequency operation ($\lambda > \sim$600nm) of these lenses results in the excitation of extended surface plasmon waves, whereas operation at the localized plasmon frequency ($\lambda \sim$ 550nm) results in a narrowed field distribution in the image plane, as predicted by theory.