Talk Title
Designing Hierarchical and Quasi-3D Plasmonic Lattices

Abstract
The interaction of light with surface plasmons—collective oscillations of free electrons—in metallic nanostructures has resulted in demonstrations of enhanced optical transmission, collimation of light through a subwavelength aperture, and negative permeability and refraction at visible wavelengths. The structures that display these phenomena typically consist of ordered arrays of particles or holes with sizes of the order 100 nm. Surface plasmons can interact with each other over much longer distances, however, and thus the ability to organize nanoscale materials over multiple length scales could lead to new plasmonic metamaterials with novel optical properties. This talk will describe how a multiscale patterning approach—soft interference lithography (SIL) combined with **PEEL**—can be used to create a wide range of hierarchically structured, plasmonic materials. PEEL is a simple procedure that combines **P**hase-shifting photolithography, **E**tching, **E**lectron-beam deposition, and **L**ift-off of the metal film. Typical patterned areas exceed 1 in^2.

We will describe the extraordinary optical properties of metal films perforated with near-infinite arrays of 100-nm holes as well as films patterned with pyramidal pits. These systems exhibit ultra-sharp spectral features that can be tuned by changing the material, dielectric environment, and excitation conditions. Significantly, the origin of these complex transmission spectra can be described by a new optical coupling mechanism. We measured dispersion diagrams of these artificially structured materials that were analogous to electronic materials. The prospects for using our nanofabrication platform to screen for and to test new plasmonic media will be discussed.