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A Technique for Nanoscale Plasmonic Imaging via Photoemission

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The scientific community is witnessing increased research activity on Surface Plasmon Polaritons (SPPs). The potential applications of SPPs and plasmonic structures based on their control and manipulation are truly multi-disciplinary, spanning high speed nano-scale interconnects, meta-materials, chemical and biological sensing, sub-wavelength optics and waveguides, near-field optical trapping, high-density data storage, and the enhancement of non-linear effects. Measurement of the localized optical field intensity is a critical component in validating physical models and characterizing plasmonic structures. The dominant technique employed for this task is the Scanning Near-Field Optical Microscope (SNOM) or Photon Scanning Tunneling Microscope (PSTM), whose contrast mechanism is based on measuring light scattered from the near-field with a probe. These techniques can provide high resolution images of the localized fields, but they are slow. Furthermore, tip-sample interactions can perturb the fields, yielding ambiguity between electric and magnetic fields and frustrating attempts at accurate optical characterization. One way to facilitate the advance of plasmonics is to develop new techniques for imaging and characterizing SPP behavior on the nanoscale. Recent efforts employing photoemission to reveal the localized fields have demonstrated that this technique can provide both high spatial ($\sim$10nm) and temporal (fs) resolution when combined with a Photoelectron Emission Microscope (PEEM)[1-3]. The PEEM does not require a probe so the fields can be imaged without perturbation. It also provides a parallel image of the full field, so acquisition times are fast. We are expanding the capabilities of the PEEM to exploit a novel contrast mechanism which will broaden the spectrum of plasmonic devices observable. We present our experimental efforts in this area, detail the underlying physics of the contrast mechanism and discuss how it can be controlled to enable unique spatial and temporal information on the propagation of SPPs within plasmonic structures.

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