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# NANO HIGHLIGHT
# Plasmonic Nanostructured Devices for Chemical and Biological Sensing

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A light incident to nano-structured metals can cause collective oscillations of electrons inducing density fluctuations, known as surface plasmons (SPs). Recently, surface plasmons have attracted much interest in subwavelength optics, which is expected to find major applications in lithography, imaging, beam shaping, filtering, biochemical sensing, etc.

We have investigated surface plasmon interactions in a metallic nanoslit array structure that shows characteristic transmission spectra with well-defined transmission minima and maxima in the visible-to-infrared range. The time evolution of the surface plasmon resonances occurring in various different regimes of the spectra was analyzed by performing finite-difference time-domain (FDTD) analysis of the plasmon field, energy flow, and polarization charge distributions in the nanoslit array structure. Optical interactions with a nanoslit array are found to involve different modes of SP resonances occurring at different sections of metal surfaces, and can be understood in terms of the polarizability of the medium (metal islands separated by slits) and the periodic arrangement of nano-slits which serve as energy flow channels with a funneling effect. The designability of metallic structure's polarizability offers a promising potential for developing a variety of plasmonic nano-optic devices [2].

We have imaged the spatio-temporal dynamics of localized surface plasmons by combining the interferometric time-resolved two-photon photoemission (TR-2PP) technique with the photoelectron emission microscopy (PEEM). We observed the quantum interference of SP polarization waves that occur at nanometer-scale random roughness (so-called hot spots in SP imaging) on silver grating surface (Figure). The dynamical imaging of surface plasmons in the sub-optical cycle regime adds a new dimension to the study of plasmonic nanostructures [3].

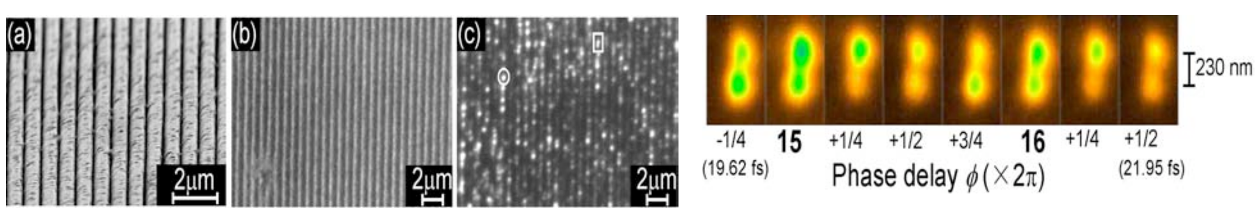


Figure (left): micrographs of silver nanoslit arrays: (a) SEM, (b) PEEM with 254-nm light excitation (1PP-PEEM), (c) 2PP-PEEM with 400-nm fs-laser excitation.
Figure (right): TR-PEEM micrograph of a hot spot on the silver nanoslit array (marked with a rectangle in (c)). Recorded at a rate of 0.33 fs/frame. The phase delay indicates the pump-probe delay time.

**References**

[1] For further information about this project email **<kim@engr.pitt.edu>**
[2] Z. Sun, Y.S. Jung, and H.K. Kim, Dynamic evolution of surface plasmon resonances in metallic nanoslit arrays, *Applied Physics Letters* (submitted).
[3] A. Kubo, K, Onda, H. Petek, Z. Sun, Y.S. Jung, and H.K. Kim, Imaging of localized silver plasmon dynamics with sub-fs time and nanometer spatial resolution, *Proceedings of the 14th International Conference on Ultrafast Phenomena*, Niigata, Japan, July 25-30, 2004 (invited paper).