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Femtosecond time-resolved photoemission electron microscopy and directed launching of propagating surface plasmons WAYNE HESS, YU GONG, ALAN JOLY, PATRICK EL-KHOURY, Pacific Northwest National Laboratory — We image propagating and localized surface plasmons (PSPs and LSPs) on noble metal surfaces using femtosecond time-resolved photoemission electron microscopy (tr-PEEM). Our experiments employ identical, spatially separated, and interferometrically-locked femtosecond laser pump-probe pulses with a time step resolution of 210 attoseconds. The recorded time-resolved movies of PSPs allow us to directly measure various properties of the surface-bound wave packet, including its carrier wavelength (785 nm) and group velocity (0.95c). In concert with finite-difference time domain simulations, tr-PEEM results indicate a lower limit of 75 μm for the decay length of the PSP on gold. In addition we discuss coupling and interferometric focusing of PSPs using nanohole arrays. Recorded photoemission patterns are attributed to constructive and destructive interference between propagating surface plasmons launched from individual nanoholes. We demonstrate how varying the array geometry (hole diameter, pitch, and number of rows/columns) ultimately yields focused photoemission patterns. Finally, we demonstrate polarization directed launching of surface plasmons, from simple symmetric trench nanostructures, and explain effects of laser polarization on coupling to PSP and LSP modes.

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