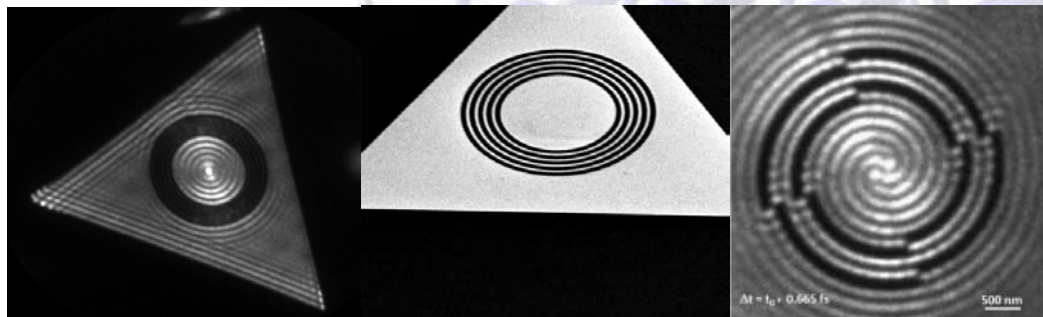


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Nanofocusing and Orbital Angular Momentum of Short-Range Surface Plasmons in Single Crystalline Gold Flakes

We use single crystalline gold flakes on atomically flat silicon substrates to generate ideally suitable metals for plasmon propagation. By electrochemical means, the thickness is tunable from a few tens to over 100 nm. Using sub-20 fs laser pulses around 800 nm, we excite surface plasmons, whose dynamics can be observed using time-resolved two-photon excitation electron emission (PEEM).

Plotting the dispersion of surface plasmons in a thin gold slab on silicon, one finds that excitation at 800 nm can lead to extreme wavelength reduction due to the dispersion slope of over five. Using focused ion beam for cutting rings with appropriate periodicity into the samples (see left image), we can excite concentric surface plasmons that create a nanofocus of only 60 nm width for 800 nm excitation (see center image).



Using Archimedean spirals with broken n-fold radial symmetry, it is possible to excite surface plasmons with angular orbital momentum on the gold flakes (see right image). This leads in case of 4-fold symmetry to cloverleaf-type nanofoci on the order of 100 nm, which rotate during four optical cycles by 360 degrees.

Using two-pulse experiments with a subwavelength-stabilized Michelson interferometer, it is possible to observe the dynamics of the surface patterns with a (sub-)femtosecond resolution, thus giving insight into the dynamics of the nanofocus formation as well as on the plasmonic spin-orbit coupling.

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