Attosecond soft X-ray pulses : From XUV attosecond pulse control by aperiodic multilayer optics to localized surface plasmon field dynamics

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Synopsis XUV multilayer mirrors serve as powerful reflective optics to control the spectrum and phase of attoseocnd HHG pulses which is an important requirement for measuring time-resolved photoelectron emission dynamics from solid surfaces and nanostructures. Based on a time-of-flight photoelectron emission microscope, a new experiment for spatial and temporal characterization of photoelectron dynamics and localized surface plasmon fields is presented.

Attosecond soft X-ray pulses from High Harmonic Generation filtered by bandwidth and phase optimized multilayer soft X-ray mirrors serve as a powerful light source for XUV pulses with pulse duration less than 100 attoseconds [1]. Besides the HHG generation process, subsequent spectral filters and optics play an important role for the spectral and temporal properties of the XUV pulses in the experiment. Multilayer mirrors are powerful optical elements to control the spectrum and the phase of the reflected pulses resulting in compressed XUV pulses of minimum time duration or chirped XUV pulses of controlled dispersion. We report on our XUV multilayer optics development spanning the photon energy range from the Extreme Ultraviolet (~ 100 eV) to the "water window "soft X-ray range (280-500 eV), which is particularly important for studying in-vitro samples.

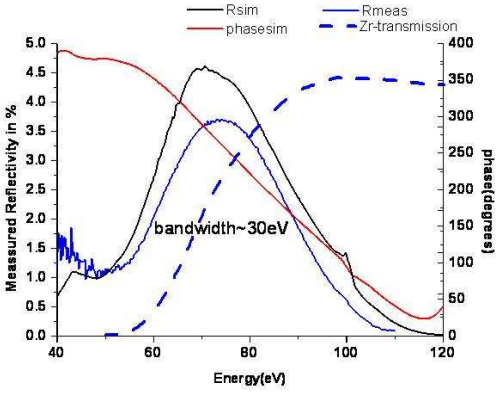

Figure 1. Reflectivity and phase of an attosecond multilayer mirror at 60-90 eV photon energy [1]

In nanoscience, one of important topics is the study and utilization of phenomena that are localized on the nanoscale and ultrafast. The localization length of surface plasmons can be on the order of several nanometers. The relaxation time of surface plasmons is in the 10-100 fs range, allowing coherent control of nanoscale localization with femtosecond laser light. Importantly, collective motion in plasmonic nanosystems unfolds on much shorter, attosecond time scales. Here we propose a principally new approach that will allow one to *directly* measure the spatiotemporal dynamics of the nanolocalized optical fields with ~100 as temporal resolution and nanometer spatial resolution [2]. Measurement of nanolocalized optical fields is interesting from both the fundamental positions and in view of the multiple applications of nanoplasmonics.
First steps towards the experimental realization of an *attosecond nanoplasmonic field microscope*, based on a ToF PEEM with 2PPE excitation or as XUV excitation, are reported [3].

References

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