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SFB 652

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Extreme Ultraviolet Nanoscopy and Ultrafast Time-resolved Spectroscopy Using High Harmonic Radiation

The advent of laser-driven ultrafast sources based on high harmonic generation (HHG) spanning the extreme ultraviolet (XUV) into the soft X-ray regime offer magnificent opportunities for time-resolved research. Their short wavelength and excellent coherence properties enable microscopy applications at the nanoscale and at shortest timescale. Tremendous progress has been made towards better resolution and shorter exposure times since the first demonstration of employing a HHG source for coherent diffraction imaging in 2008. In this talk recent developments towards reaching 10 nm spatial resolution with a table-top instrument using coherent diffraction imaging will be presented [1]. One strength of coherent imaging techniques is resolving the object under test in amplitude and phase, which automatically incorporates known visible light imaging regimes, such as phase contrast or dark-field microscopy. The high resolution and contrast achieved can for instance be applied for imaging unlabeled specimen in reflection geometry [2] allowing for classifying breast cancer cells diffraction pattern analysis [3]. Another strength of high harmonics is the ultimate time resolution down to about a hundred attoseconds due to the large bandwidth in the XUV. Time-resolved spectroscopy using HHG allows element, oxidation state and charge specific investigations and as such has the ability to unravel complex charge dominated processes at shortest time scales. Recent progress on time domain spectroscopy on charge dynamics in semiconductors will be presented [4], revealing electron and hole dynamics at unprecedented temporal resolution [5]. Finally, prospects of the field towards two-dimensional attosecond spectroscopy in highly anisotropic materials and bio-relevant molecules along with latest experimental developments will be discussed.

[1] M. Zürch, et al., *Nature Scientific Reports* **4** (7356), 1-5 (2014)
[2] M. Zürch, et al., *Optics Express* **21** (18), 21131-21147 (2013)
[3] M. Zürch, et al., *Journal of Medical Imaging* **1** (3), 031008 (2014)
[4] L. J. Borja, M. Zürch, et al., *Journal of the Optical Society of America B* **33** (7), C57-C64 (2016)
[5] M. Zürch, et al., *International Conference on Ultrafast Phenomena*, New Mexico, July 18th 2016

Einlader: Thomas Fennel