New Opportunities at the Nanoscale using New VUV-EUV Laser Sources

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Recent years have seen the development and increasing maturation of tabletop-scale coherent laser sources at short-wavelengths spanning from the UV into the x-ray regions of the spectrum. These sources, implemented through strong-field high-order harmonic generation driven by a femtosecond laser, have found increasing use in a variety of scientific applications, including nanoscience and nanotechnology. In this talk, I will describe the state of the art of these sources, as well as our work using them for static and dynamic nanoimaging applications. The capabilities of these sources is continually progressing. In this talk, I will focus on KMLabs' implementation of fully-integrated sources, including the XUUS$_4$^{TM} system[1] for generation of coherent light up to $h\nu$>100 eV at >10 kHz repetition-rates, and the Y-Fi VUV^{TM}, a fiber laser-based source capable of generating coherent ionizing radiation up to $h\nu$~11 eV at MHz repetition-rates.

The excellent coherence of these sources make them well-suited for recently-developed coherent diffraction imaging (CDI) techniques, that allow for the first time imaging in this region of the spectrum with diffraction-limited, sub-wavelength resolution. Examples of these imaging capabilities include our recent demonstration of 12.6 nm resolution using λ=13.5 nm illumination,[2] EUV nanoimaging in reflection,[3] the first femtosecond-resolution "movies" of surface acoustic wave dynamics,[4] and the use of these sources to characterize self-assembled colloidal crystals. These demonstrations establish EUV imaging as a viable new nanoimaging technique that combines aspects of SEM and AFM imaging with new elemental constrast mechanisms and the ability to access buried structures.[5] The possible use of these sources in APT both as an ionizing source, and for imaging tip shape during APT operation, will also be discussed.

References:

[1] KMLabs. (2017, 11/12/2017). XUUS™ Coherent EUV and Soft X-Ray Source. Available: https://kmlabs.com/product/xuus/
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[4] J. R. M. Karl et al., "Stroboscopic Imaging of Acoustic Waves in Nanostructures using Tabletop High Harmonics," in Imaging and Applied Optics 2017 (3D, AIO, COSI, IS, MATH, pcAOP), San Francisco, California, 2017, p. CW1B.2: Optical Society of America.
[5] E. R. Shanblatt et al., "Quantitative Chemically Specific Coherent Diffractive Imaging of Reactions at Buried Interfaces with Few Nanometer Precision," Nano Letters, vol. 16, no. 9, pp. 5444-5450, September 2016.