

Laboratory based sources and optics for soft X-ray spectroscopy in the water window and at transition metal L-edges

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Laboratory based laser driven short pulse X-ray sources like laser produced plasmas (LPP) and high harmonic generation (HHG) exhibit a great potential for spectroscopy in the soft X-ray range. These sources are complementary to large scale facilities like synchrotrons or free electron lasers. For applications of LPP or HHG sources for time-resolved X-ray absorption spectroscopy in the water window (280 – 540 eV) or beyond, e.g. at the transition metal L-edges or M-edges of rare earth metals the available photon flux is crucial.

In our talk we present two lab based soft X-ray sources (SXR). Our highly brilliant LPP SXR source emits picosecond pulses in a wide photon energy range from 50 – 1500 eV. The HHG source pumped by a high average power thin disk laser OPCPA system delivers femtosecond pulses in a photon energy range from 100 – 650 eV with an average flux up to $3 \cdot 10^6$ ph/s in 0.1% bw in the water window.

Reflection zone plate optics (RZP) on bent substrates exhibit a high efficiency [1]. The spectral resolution of a lab based RZP spectrometer setup amounts to $E/\Delta E \approx 1000$ [2]. Both properties make RZP optics very well suited for Near Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy in the lab.

We will present two experimental setups based on our LPP and HHG SXR sources and RZP optics delivering high quality NEXAFS data. In conclusion we will discuss the application of these setups for pump-probe experiments on organic molecules in the water window as well as at L- and M-edges of magnetic materials.

[1] Probst, J., C. Braig and A. Erko, 2020, Applied Sciences **10**, 7210.

[2] Jonas, A., T. Meurer, B. Kanngießer and I. Mantouvalou, 2018, Review of Scientific Instruments **89**, 026108.