Ultrafast NEXAFS spectroscopy in the lab using laser-based sources and advanced X-ray optics

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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 (550 – 1500 eV, e.g. at the transition metal L-edges or M-edges of rare earth metals) the available photon flux is crucial. The available photon flux strongly depends on energy, pulse duration and repetition rate of the pump laser. Depending on the experimental needs in time-resolved experiments pulse durations of the X-ray pulse ranging from nanoseconds (e.g. for applications in catalysis) to sub-femtoseconds are required maintaining a jitter-free synchronization with the optical pump pulse. Thin disk laser technology provides the opportunity to tune the properties of a laser system in order to meet these requirements.

In our talk we will shortly review newest developments in the field of ultrafast Near Edge X-ray absorption (NEXAFS) in the lab. We will present our tailor made CPA thin disk laser system (1.5 ps pulse duration, 150 mJ pulse energy, 100 Hz repetition rate) for a highly brilliant LPP source emitting soft X-rays in the photon energy range between 100 and 1500 eV. This source is equipped with a high resolution X-ray spectrometer based on advanced reflection zone plate optics. We will show that the setup deliver high quality NEXAFS data allowing pump-probe experiments on organic molecules in the water window as well as at L- and M-edges of functionalized materials.

In conclusion we will discuss the application of high average power thin disk lasers in OPCPA systems for high photon flux HHG generation in the water window and beyond.