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Near edge X-ray absorption fine structure (NEXAFS) spectroscopy in the 0.2-1.5 keV spectral range using a laser-plasma soft X-ray source

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We present compact table-top laboratory system for Near Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopy based on laser-plasma soft X-ray source (LPXS). Soft X-ray (SXR) radiation is generated by the interaction of nanosecond laser pulses from a compact Nd:YAG laser (EKSPLA, Vilnius. Lithuania) producing laser pulses of a pulse energy E_L = 0.6 J and duration 3 ns at a repetition rate of 10-Hz) with a double-stream Kr/He or Xe/He gas-puff target. The SXR emission from the Xe/He target covers the energy range of ~200–1500 eV (wavelength of 0.8 nm to 5.6 nm), as shown in Figure 1.

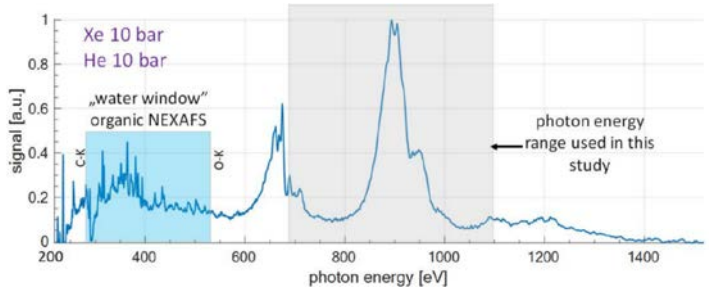

Figure 1. SXR reference spectrum in the photon energy range of 200–1500 eV, obtained for Xe and He gas backing pressures of 10 bar.

Such a broadband emission enables NEXAFS studies of low-Z materials near the K-edge (e.g. C, N, O) and some elements of higher-Z (e.g. transition metals) near the L- and M-edges.

LPXS illuminates a thin sample placed in a small load-lock downstream the beamline, and then the SXR light is transmitted through the sample, forming a sample beam. The holder allows also some portion of the SXR wavefront, called a reference beam, to enter the spectrometer entrance slit directly . In this way, simultaneous acquisition of two spectra can be achieved. We can call this approach "a dual-channel SXR spectrometer". Such a solution allows spectral acquisition and NEXAFS measurements to remain unaffected by mechanical instabilities or energy fluctuations of the source.

Emission spectra were recorded using a home-made SXR spectrometer, equipped with a grazing-incidence flat-field diffraction grating (Hitachi High Technologies America, Inc., Schaumburg, IL, USA). The spectrometer was also equipped with a 100 μm wide entrance slit, located ~715 mm from the plasma source. A CCD camera (GE 20482048, greateyes, Berlin, Germany) with a 2 k × 2 k chip, each pixel of 13 × 13 μm^2 in size was used for detection and storage of the SXR spectrum.

The effectiveness of our NEXAFS system has been proven in experiments in which various oxides, including reduced graphene oxide rGO, TiO_2 and Fe, were investigated[2,3].

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References

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