A compact and efficient von Hamos spectrometer based on two full-cylindrical HAPG mosaic crystals for high-resolution XES

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X-ray emission spectroscopy (XES) presents the potential to substantially contribute to the further development of complex nano-materials and thin film applications with distinct chemical properties. In the field of catalysis, the identification and quantification of active sites is important for a more thorough understanding of catalytic systems. Using a physically traceable approach based on radiometrically calibrated instrumentation and the knowledge of atomic fundamental parameters, absolute elemental and species mass depositions or concentrations without the need for any reference material can be determined.

In this view, we will present a calibratable and compact high-resolution wavelength-dispersive spectrometer for XES in the energy range of 2.4 keV to19.0 keV. Using two full-cylindrical Highly Annealed Pyrolytic Graphite (HAPG) crystals as dispersive elements in a modified von-Hamos geometry [1], a large solid angle of detection resulting in high detection efficiency is realized while achieving a moderate to high resolving power. HAPG is a synthetic type of carbon which forms mosaic crystals and can be mounted to substrates with small radii of curvature. Although the peak reflectivity is smaller than for perfect crystals, the crystal mosaicity results in an increased integrated reflectivity [2].

In this work we will show the instrumental characterization of the spectrometer including achievable energy resolution and efficiency as well as the spectral response as a function of experimental parameters. Furthermore, the chemical speciation capability of the device is demonstrated on the basis of different transition metal compounds. The calibration of the instrumental response of the presented wavelength-dispersive spectrometer enables an accurate determination of binding state related structures in X-ray spectra, thus enabling reliable identification and discrimination capabilities contributing to a thorough uncertainty budget.

Thus, a calibration procedure for fully quantitative experiments at synchrotron radiation facilities is being developed in order to progress towards traceable, quantitative XES measurements. This procedure will be demonstrated on the basis of the determination of L-shell atomic fundamental parameters of gadolinium and requires dedicated experiments for the determination of coherent scattering cross sections.

[1] C. Schlesiger, W. Malzer, D. Grötzsch, M. Neitzel, B. Kanngießer, 2014, Rev. Sci. Instrum. **85(5)**, 053110

[2] M. Gerlach, L. Anklamm, A. Antonov, I. Grigorieva, I. Holfelder, B. Kanngießer, H. Legall, W. Malzer, C. Schlesiger, B. Beckhoff, 2015, J. Appl. Crystallogr. **48(5)**, 1381-1390.