

XES Microspectroscopy: A new von Hamos Spectrometer for tender x-rays at the PHOENIX beamline

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Introduction

The PHOENIX beamline provides tender X-rays in the range of 0.4 to 8 keV. The undulator based beamline provides a microfocus with a spotsize of about 3×3 micrometer for applications in both imaging and X-ray spectroscopy. The modes of operation are fluorescence spectroscopy using Silicon Drift Detectors (SDD), total electron yield mode and transmission.

High resolution X-ray emission spectroscopy (XES) provides unprecedented insight into molecular structure and chemical environments of probed atoms, as it has been shown in applications related to magnetic materials, catalysis or coordination chemistry. As the energy resolution of SDD detectors is limited to about 120 eV, the study of the fine structure of emission lines requires a crystal to analyze the photon energy spectrum. Here we present a new compact von Hamos spectrometer, which is designed for the energy range of 2.05 to ~ 4 keV.

Experimental Methods

The von Hamos spectrometer is fully integrated into the PHOENIX beamline. The standard setup of the beamline uses an SDD fluorescence detector mounted in the horizontal plane in 90 degree relative to the incoming beam. The spectrometer's analyzer crystal and 2-D detector are mounted in the vertical axis above the sample on a manipulator. The von Hamos spectrometer uses a crystal (Si [111] cut) with 7 cm radius. The detector is the novel Moench 2-D detector, which is a PSI in-house development. It has a physical pixel size of 25 μm , which can be reduced to an effective pixel size of 12.5 μm by an interpolation method. Currently, the energy range from ca 2.2 to 3 keV is available, allowing for XES at the S, Cl K edge, but additional crystals will provide access to the full energy range.

Results and conclusion

The spectrometer provides an energy resolution of less than 1 eV, if the micro focus in the order of 10 μm or less is used. This allows for example the analysis of the fine structure of the $K\alpha$ and $K\beta$ lines of light elements (P-Ca). Most importantly, as the spectrometer is fully integrated into the standard beamline setup for microspectroscopy and imaging, XES can be easily combined with any routine imaging study at the beamline.