A Versatile Tender X-ray Emission Spectrometer for Benchtop Analytical XES and Synchrotron RIXS Without Constraint on Source Size

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X-ray absorption and emission spectroscopy in the 2 – 4 keV x-ray regime has recently seen a growing interest, especially for study of S and P K-edges and actinide M-edges, and the development of synchrotron beamlines and associated endstations in this energy range has been a topic of ongoing effort. We have approached this situation from a dual perspective, seeking to more easily enable synchrotron RIXS and XES while also achieving benchtop capability for a new analytical access to high-resolution XES for elements with strong fluorescence in this energy range. In particular, we have developed a compact, easily portable spectrometer in this energy range that makes use of a 'dispersive Rowland refocusing' geometry that allows the use of a large source size at no cost in energy resolution.[1]

The spectrometer has an extremely small footprint, ~20 × 20 × 20 cm^3, due to the use of a 10-cm radius of curvature cylindrically bent silicon analyzer. First, in the laboratory setting, x-rays are generated using a low-power, 50 W x-ray tube, which produces an unfocused broadband beam incident on the sample. The analyzed rays are detected using a laboratory-developed color x-ray camera[2] that is placed tangent to the Rowland circle defined by the cylindrically-bent analyzer. For each event, the x-ray camera identifies the energy of the photon to ~200 eV resolution in addition to its position with ~3 micron spatial resolution. Selection of an energy window for detected photons gives strong background rejection and allows efficient measurements on even dilute samples without extreme effort to reject internal stray scattering. Second, without modifying the optical configuration, we replace the x-ray tube with the exit pipe of a synchrotron beamline for measurements of resonant XES and RIXS. In both cases, the absence of sensitivity to the beam spot size allows the use of unfocused incident radiation, thus greatly decreasing potential beam damage – a common problem in this energy range.

In this talk we describe details of the spectrometer design and operation, and briefly survey a variety of completed studies and sample measurements, spanning from new benchtop analytical capabilities[3,4] to synchrotron-based actinide M-edge RIXS, all with high resolution and measurement efficiency.

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2. O. R. Hoidn, W. M. Holden, G. T. Seidler, *in preparation*, Rev. Sci. Instrum (2018).
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4. J. Stein, B. Cossairt, W. M. Holden, et al., *in preparation*, Analytical Chemistry (2018).

This work was supported by the United States Department of Energy, National Science Foundation, and Los Alamos National Laboratory.