Bent Laue Analyzer for Fluorescence XAFS: Initial Results

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Introduction

X-ray absorption fine structure (XAFS) is a powerful tool for structure determination in solids, liquids, and molecular gases. XAFS allows the experimenter to "tune into" a specific element and probe the structure of its immediate environment. Energy-resolving detectors or analyzers are desired to extract the x-ray fluorescence signal from the scattered background. The bent Laue analyzer[1,2] is a potentially important tool for fluorescence XAFS of dilute species under high-flux conditions that may saturate solid-state detectors.

Methods and Results

The analyzer is a thin bent Laue crystal of logarithmic spiral shape[3] held in a machined frame. A large solid angle of x-ray fluorescence emitted by a sample can be collected with moderate reflectivity using the asymmetric [111] reflection of a silicon crystal 200 microns thick. A set of Tin (Sn) soller slits to match the virtual x-ray source and reject scatter was designed and fabricated. The slits and crystal frames then were fixed by attaching the frames to each other. Experiments were carried out on the MR-CAT beamline at the APS. A $NaMoO_4$ aqueous solution was used as a sample to obtain XAFS spectra of Mo (molybdenum) fluorescence. The source-to-crystal distance has been optimized to around 175 mm, as calculated. Figure 1 shows the rocking curve of Mo fluorescence.

The crystal analyzer was then positioned to the peak value of K_α line of molybdenum sample for XAFS scan (Fig. 2).

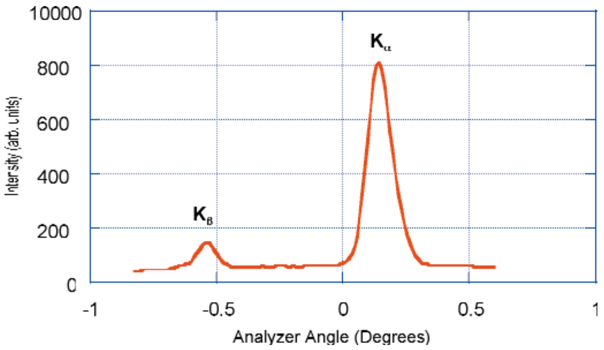

FIG. 1. Rocking curve of a 10 mM dilute solution of Mo showing K_α and K_β lines.

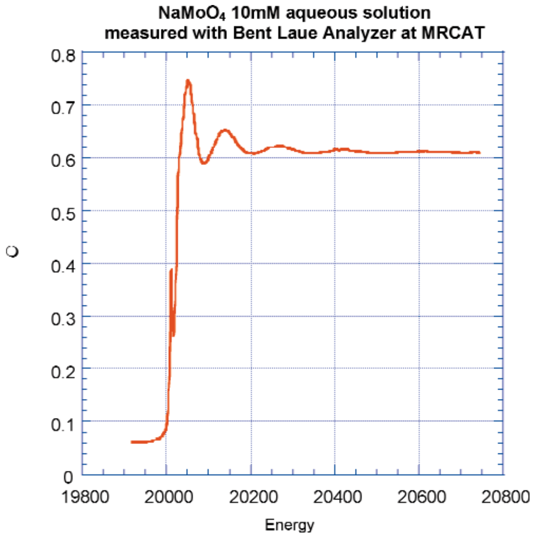

FIG. 2. The XAFS spectra of a 10 mM molybdenum solution using the bent Laue analyzer.

Discussion

The data quality obtained with the analyzer demonstrates the viability of the device, especially if scaled to multiple elements. The fixed crystal-slits combination also gave us a higher signal ratio and increased the performance (reduced the background-signal ratio) compared to the separate crystal-slits configuration.[2] Further optimization, testing, and engineering design will be needed to achieve its potential and is in progress.

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References

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