From point-to-point, to continuous and quick scanning EXAFS: achieving time resolution

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Introduction

Quick scanning X-ray absorption spectroscopy (XAS) is gaining increasing importance. Not only does this technique boost experimental methods, which require a large number of spectra, such as XANES mapping or tomography XAS, it also adds time resolution to XAS on a very useful scale.[1] Users today can get access to beamlines providing scan rates in the range of a few minutes or seconds down to just a few milliseconds per spectrum.[2, 3] While sub-second scan rates require specialized dedicated monochromators, scan rates in the domain of seconds can be achieved with conventional double crystal monochromators by using highly integrated motion control and data acquisition systems. At the Stanford Synchrotron Radiation Lightsource (SSRL) this technique is in addition combined with energy dispersive fluorescence detectors and currently being implemented at all spectroscopic beamlines. This upgrade, its capabilities and a future outlook to achieve sub second time resolution will be discussed.

Methods

In contrast to point-to-point measurements, continuous and quick scanning implementations acquire absorption spectra while the monochromator smoothly shifts the incident X-ray energy across the scan range. To obtain the best data quality possible customizable energy-time scan curves, which account for damped EXAFS at high k values can be defined with our implementation of continuous scanning. This is typically not possible with quick scanning which rely on a sinusoidal monochromator crystal oscillation.

Results and discussion

The difference in implementation and capabilities of continuous and quick scanning EXAFS will be discussed. Selected experiments originating from catalysis and material sciences performed at the Swiss Light Source (SLS, Switzerland), PETRA III (DESY, Germany) and SSRL (SLAC, USA) will be shown to underline the capabilities of modern setups.

Conclusion

Compared to conventional point-to-point scanning, continuous scanning XAS techniques can yield higher data quality on an even shorter acquisition time. Scan rates on a second scale can be achieved with conventional monochromators. The sub second domain requires more specialized hardware, such as dedicated monochromators and gridded ionization chambers.[3, 4] With this kind of setup time resolution of few milliseconds is possible today.

SSRL is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, Contract No. DE-AC02-76SF00515.

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