

Operando XAS for chemistry at BM23 and ID24-DCM beamlines of the ESRF

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BM23 and ID24 are ESRF beamlines that specialize primarily in X-ray absorption spectroscopy, but also offer an impressive set of complementary characterization techniques. Main fields of in-house research and user activity are operando chemistry (catalysis, electrochemistry, etc), materials science, environmental science, physics and geoscience. Both beamlines have been deeply refurbished within the EBS upgrade program.

BM23 is multi-purpose XAS beamline optimized for high-quality XAS measurements between 4.5 and 90 keV (for mm beam) and 4.5-45 keV (for μm beam), in transmission or fluorescence mode. Its brand-new monochromator developed in the ESRF allows collecting XAS spectra in continuous mode in a few seconds with unprecedented energy and beam position stability. BM23 offers a large variety of sample environment: in situ cells, cryostats, ovens, gas infrastructure, high-pressure equipment, mass-spectrometer for gas analysis and more. Pilatus 1M detector is available for complementary XRD measurements. Simultaneous XAS and DRIFTS measurements under controlled temperature and gas flow are possible thanks to the dedicated DRIFTS/XAS/MS setup. The microXAS station for focusing the beam below $5 \times 5 \mu\text{m}^2$ FWHM with 10^9 ph/s is also available for space-resolved studies.

ID24 beamline consists of two branches with very distinct instrumentation and applications. Energy dispersive branch (ID24-ED) is coupled with high-power laser facility (HPLF) and is dedicated mainly to laser shock experiments in physics and planetary science. Energy dispersive scheme allows ultra-fast measurements (down to 100 ps/spectrum), ideal for time-resolved studies.

Scanning branch of ID24 (ID24-DCM) is a high brilliance XAS beamline equipped with the same novel double-crystal monochromator as BM23. The accessible X-ray energy ranges from 5 to 45 keV. Taking advantage of the new EBS characteristics, ID24-DCM combines high flux up to 10^{13} ph/s from undulator source with variable X-ray beam size from $1 \times 1 \text{ mm}^2$ down to $500 \times 500 \text{ nm}^2$ FWHM. The new DCM allows collecting XAS spectra in a few seconds even in fluorescence mode. A Pilatus 2M detector is permanently installed on the beamline for complementary XRD measurements. High energy resolution fluorescence detected XAS is available thanks to 5-crystal spectrometer. MicroXAS station allows focusing the beam down to $500 \times 500 \text{ nm}^2$ FWHM if needed. ID24-DCM is compatible with all chemistry sample environment of BM23, including cells, gases and DRIFTS/XAS/MS setup.

The talk will be devoted to the demonstration of the performance of BM23 and ID24-DCM beamlines and their application to chemistry studies, including catalysis, synthesis of novel materials and electrochemistry. Recent highlights from both user-driven and in-house research will be presented.