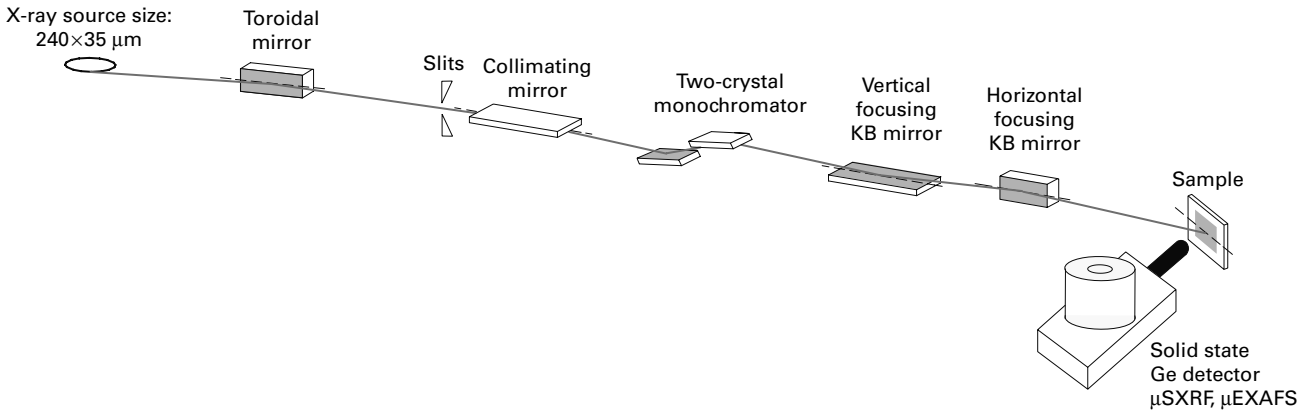
Micro X-Ray Absorption Spectroscopy for Environmental and Materials Science • Beamline 10.3.2

Berkeley Lab • University of California

Beamline Specifications

Photon Energy Range (keV)	Photon Flux (photons/sec/0.01%BW)	Spectral Resolution (E/ΔE)	Spot Size (μm)	Availability
2.5–17	1×10^{10} (in a 5×17-μm^2 spot)	7000	5–17 (h) 5–7 (v)	NOW



***Schematic layout** of Beamline 10.3.2.*

Beamline 10.3.2 for environmental and materials science provides for elemental analysis, chemical speciation, and local geometric structure of samples, which can be in their natural environment.

The bend-magnet beamline operates over the photon-energy range from 2.5 keV to 17 keV. Beamline optics collect 0.166 horizontal mrad, providing a flux up to 1×10^{10} photons/sec/0.3% BW in a spot 5×5 μm^2. A two-crystal silicon (111) monochromator 31 m from the source provides a spectral resolution up to 7000. Crossed elliptical mirrors in the Kirpatrick-Baez configuration provide horizontal and vertical focusing after the monochromator. The demagnification of the mirrors combined with an adjustable slit width results in a spot size at sample ranging from 5 to 17 μm horizontal × 5 to 7 μm vertical. The smaller the spot, the lower the flux. The sample is placed on an x-y scanning stage that moves the sample through the focused spot.

Core-level absorption makes experiments element specific. In a microprobe mode, x-ray fluorescence yields spatially resolved elemental analysis. Both near-edge x-ray absorption fine-structure (NEXAFS) and extended x-ray absorption fine-structure (EXAFS) spectroscopies are possible. NEXAFS spectra act like fingerprints that, by comparison with spectra from standard samples, provide information about local chemical structure, such as oxidation states. EXAFS provides quantitative determination of the local

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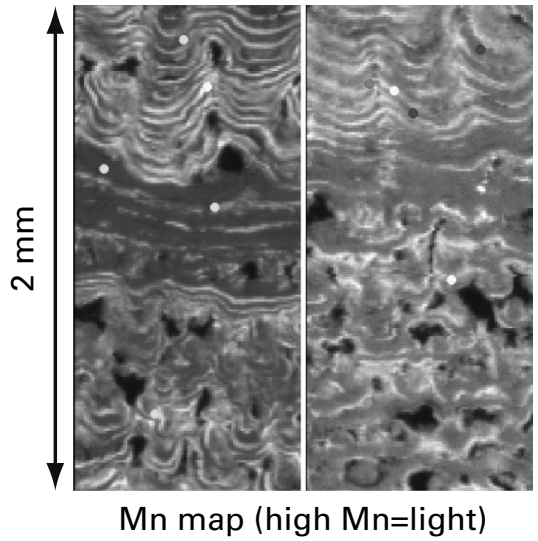
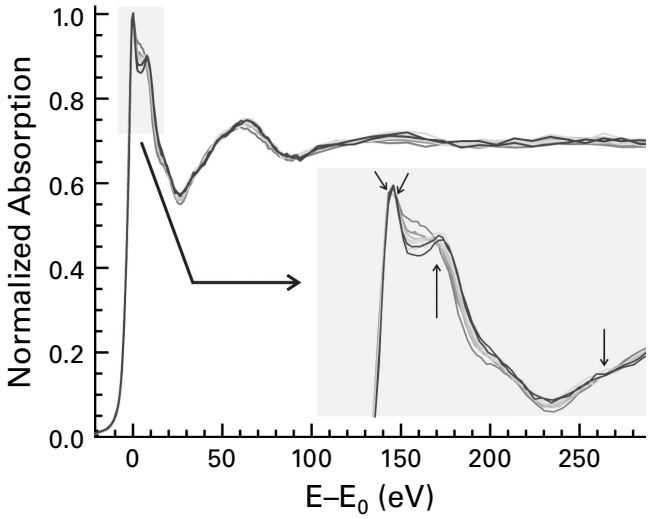
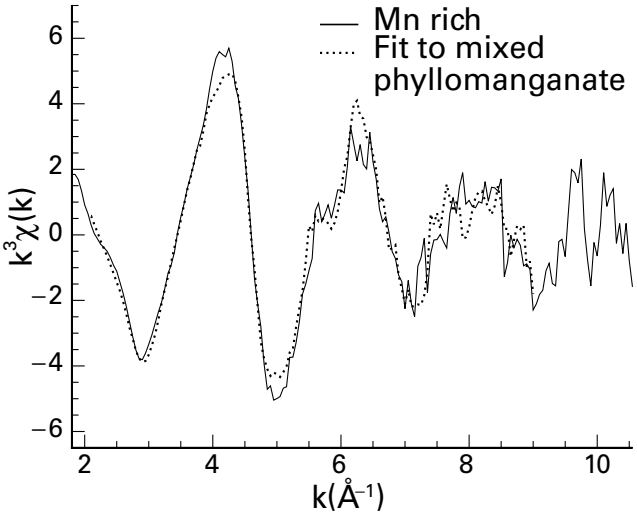
geometric structure around the absorbing atom. The scanning stage can be used to select submicron areas for spectroscopic examination and to build up elemental or chemical images by sequentially recording the signal from the spectral feature of interest from each scanned spot. A seven-element germanium detector that operates in MCA and SCA modes provides fluorescence-yield detection. ■







Microbeam environmental science applied to the problem of zinc speciation in a two-banded iron-manganese bacterial mat from a hot spring at a Japanese seashore site. (Top left) *The soft x-ray fluorescence (SXF) image shows the spatial distribution of manganese in a portion of the mat.* (Top right) *The zinc near-edge x-ray absorption fine structure (NEXAFS or XANES) spectra taken at several points of high and low manganese concentration and examined by the principal component analysis (PCA) method suggest that the spectra are linear combinations of two components with fractional contributions related to the manganese/iron ratio at the point investigated.* (Bottom right) *The zinc extended x-ray absorption fine structure (EXAFS) spectra from a manganese-rich region can be fit by a mixed phyllomanganate model (zinc-sorbed ferrihydride and zinc-sorbed birnessite). Data courtesy of M. Marcus (ALS), A. Manceau (Université Joseph Fourier and CRNS, Grenoble, France), M. Kersten (Universität Mainz, Germany), and K. Tazaki (Kanazawa University, Japan).*

To obtain a proposal form, go to www-als.lbl.gov/als/quickguide/independinvest.html.

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