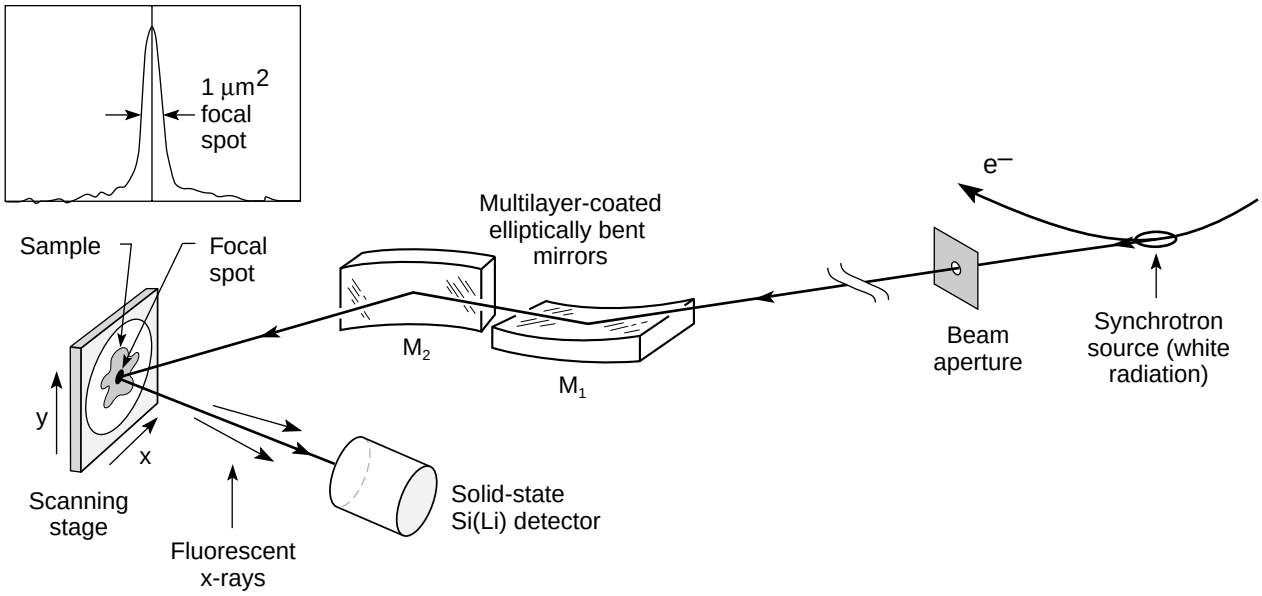
Scanning X-Ray Fluorescence Microprobe • Beamline 10.3.1

Berkeley Lab • University of California

Beamline Specifications

Photon Energy Range (keV)	Photon Flux (photons/s)	Spectral Resolution (E/ΔE)	Spatial Resolution (μm)	Samples	Availability
6–15 (with multilayer mirrors) **3–20** (without multilayer mirrors)	3×10^{10} (at 12.5 keV, with multilayer mirrors)	**25** (at 12.5 keV, determined by number of periods in multilayer mirrors)	**1.0×1.2**	**Flat Solids** (<2 cm diameter in air)	**NOW**



Schematic layout of Beamline 10.3.1.

Beamline 10.3.1 is a PRT-owned bend-magnet beamline dedicated to a scanning x-ray fluorescence microprobe for spatially resolved, high-sensitivity elemental analysis of materials, environmental systems, geological structures, and historical artifacts and documents. Owned by the Berkeley Lab's Center for X-Ray Optics, the x-ray microprobe is the x-ray analogue of the electron microprobe.

Light focused by two bendable elliptical mirrors in the Kirkpatrick-Baez configuration illuminates a small spot (less than 2-μm diameter) on the sample. The mirrors are coated with multilayer reflectors to increase the reflectivity. A Si(Li) detector records the fluorescence x rays, with the photon energy identifying the element and the intensity its concentration. Scanning the sample through the beam builds up a distribution map for both majority and trace elements.

Sensitivity is in the femtogram range for many elements in the periodic table. A particular advantage of the microprobe is its ability to analyze

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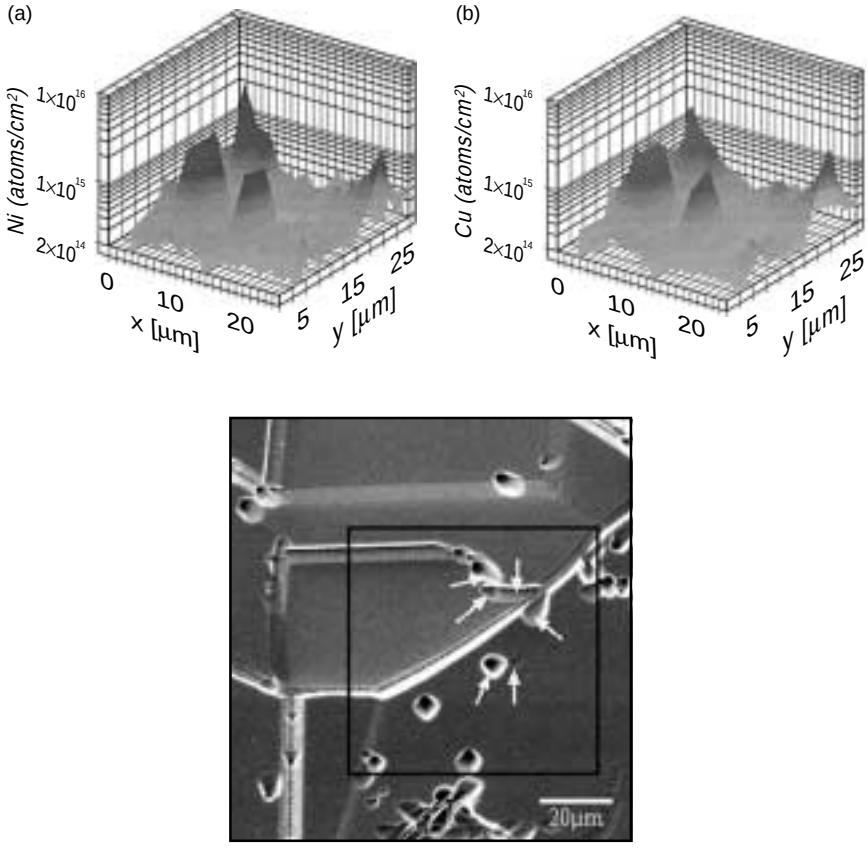
materials in ambient environments and without special sample preparation. Fluorescence x rays come from depths of tens of microns, so the microprobe is primarily sensitive to the bulk rather than the surface.

The multilayers have a band pass of about 6%, and the instrument is designed to operate at photon energies over the range from 6 to 15 keV. By arrangement, the focusing mirrors can be removed for white-light experiments from 3 to 20 keV.

The microprobe has served researchers studying such diverse subjects as impurities that lower efficiency in solar cells, grain-boundary segregation of impurities that short-circuit light-emitting diodes, strengthening additives in ceramics, heavy-metal contaminants in wetlands, and a search for toxic elements in hair from deceased persons. White-light experiments include testing x-ray components such as capillary optics, collimators, and detectors. ■



Mapping impurities in solar-cell material. X-ray fluorescence microprobe images of the distribution of nickel (a) and copper (b) in as-grown polycrystalline silicon show that these impurities, which are associated with reduced solar-cell efficiency, occur in discrete agglomerations localized within areas of 2 to 5 µm radius. Comparison of these images with a scanning electron microscope image of etched material shows that the positions of the nickel- and copper-rich areas (white arrows) correlate strongly with dislocations (black pits) but not as much with grain boundaries (lines). Data courtesy of Scott McHugo (ALS).

This beamline is available to independent investigators with the concurrence of the PRT.

For Beamline Information

Albert C. Thompson
Advanced Light Source
Berkeley Lab, MS 2-400
Berkeley, CA 94720
Tel: (510) 486-5590
Fax: (510) 486-7696
Email: acthompson@lbl.gov

PRT Spokesperson

Albert C. Thompson
Advanced Light Source
Berkeley Lab, MS 2-400
Berkeley, CA 94720
Tel: (510) 486-5590
Fax: (510) 486-7696
Email: acthompson@lbl.gov

To Obtain a Proposal Form

Bernie Dixon
User Services Office Manager
Advanced Light Source
Berkeley Lab, MS 6-2100
Berkeley, CA 94720
Tel: (510) 486-6722
Fax: (510) 486-4773
Email: alsuser@lbl.gov

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