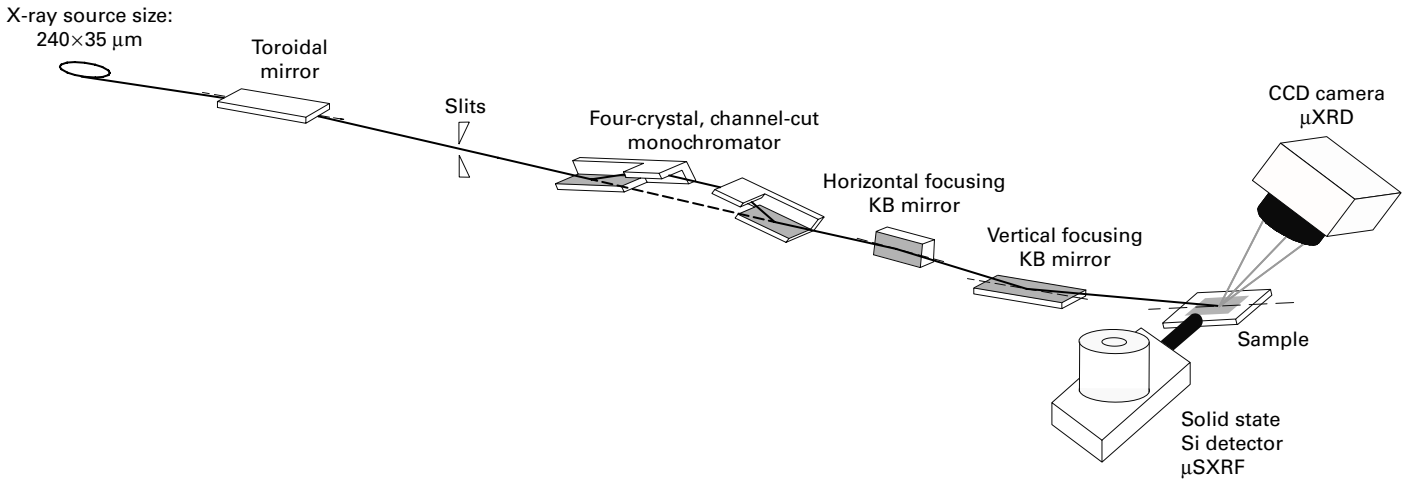
X-Ray Microdiffraction for Materials and Environmental Science • Beamline 7.3.3

Berkeley Lab • University of California

Branchline Specifications

Photon Energy Range (keV)	Photon Flux (photons/s/0.3%BW)	Spot Size (μm)	Spectral Resolution (E/ΔE)	Availability
6–12	1×10^{9}	1 μm (h) × 1 μm (v)	1000–7000 (depends on vertical acceptance)	NOW
	1×10^{12} (at 8.5 keV)	300 μm (h) × 100 μm (v)		



***Schematic layout** of Beamline 7.3.3.*

Beamline 7.3.3 serves two endstations for x-ray microdiffraction of materials and environmental samples and for development of new techniques in the hard x-ray range (6 keV to 12 keV) that could benefit from having the high-brightness of a third-generation storage ring. The source is a bend magnet where the vertical beta function of the electron orbit is very small, which results in a small electron beam size estimated at about 200 μm × 25 μm (FWHM, horizontal × vertical). The small source size and the high collimation of the x-rays lend themselves to high-brightness experiments—typically microscopy-type experiments where the sample is small (a few microns).

A platinum-coated silicon toroidal mirror produces a 1:1 focus of the source at an adjustable slit in the end-station hutch. The mirror is platinum coated and located 16 m from the bend-magnet source. It is operated at a 0.33° grazing angle, giving a cut off at about 14 keV. The adjustable slit then acts as the source for the microdiffraction station. Kirkpatrick-Baez (KB) mirrors demagnify the source (×12 horizontal, × 25 vertical). Micro-sized x-ray spots are achievable at the sample. Spot size can be traded for flux by adjusting the entrance slit size. A four-crystal monochromator in the +--+ configuration is located just upstream of the KB mirrors. This monochromator has the property of allowing both white beam (when the Bragg angle = zero) and monochromatic light to pass along the same direction such that the KB mirrors can focus both white and monochromatic light on the same point of the sample.

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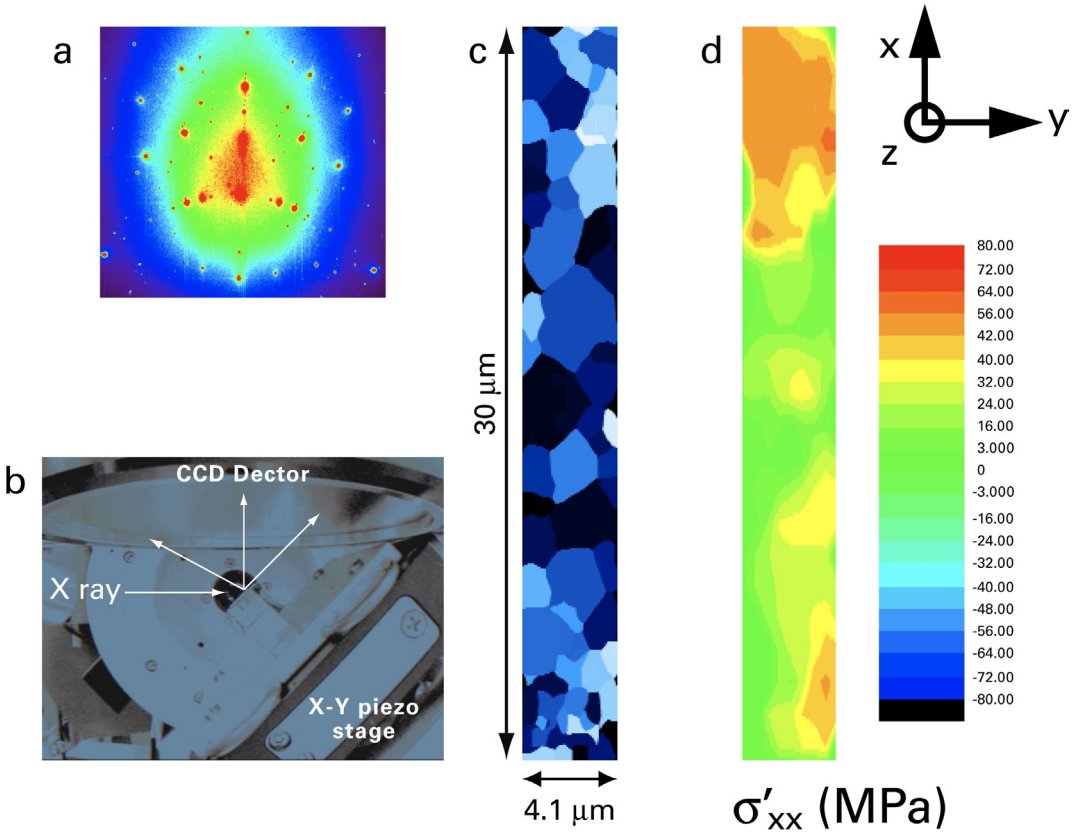
The sample itself is mounted on a six-circle goniometer with a 90-mm × 90-mm CCD area detector. The CCD is mounted on the regular 2× arm of the goniometer and can be moved radially with respect to the sample. Image plate and Si(Li) fluorescene detectors are also available. Being a six-circle instrument, the machine is very flexible and allows numerous experimental configurations when developing experiments for x-ray microdiffraction.

The end station is particularly suited for scanning x-ray microdiffraction and microfluorescence experiments with white and/or monochromatic focused beams. It allows for mapping grain orientation, strain/stress, element, and mineral species distributions of polycrystalline samples with spatial resolution ranging from a few microns to less than a micron. Examples of applications performed at the beamline are in-situ study of electromigration damages in microchip interconnect lines, deformation in polycrystaline thin film and bulk metallic samples during uniaxial tensile testing, and study of speciation of trace elements in soil nodules. ■



White and/or monochromatic focused x-ray beams *(size down to 1 µm) are used to measure the texture and strain of thin polycrystalline samples under various constraints. The sample is placed on a piezoelectrc stage and raster scanned under the beam. A diffraction pattern (a) is collected at each step using a large-area CCD detector (b). The data analysis provides the grain orientation (c) and triaxial strain/stress (d) maps of the investigated sample. The maps shown above are from an encapsulated Al(Cu) interconnect line. Data courtesy of N. Tamura (ALS).*

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

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