X-ray Optics for Diffraction Microprobe

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Introduction

• Unique capabilities for three dimensional spatially resolved measurements of phase, texture, strain and deformation distributions in single and polycrystalline materials.

• Polychromatic Laue microdiffraction. Speed and simplicity: no sample rotations are needed.

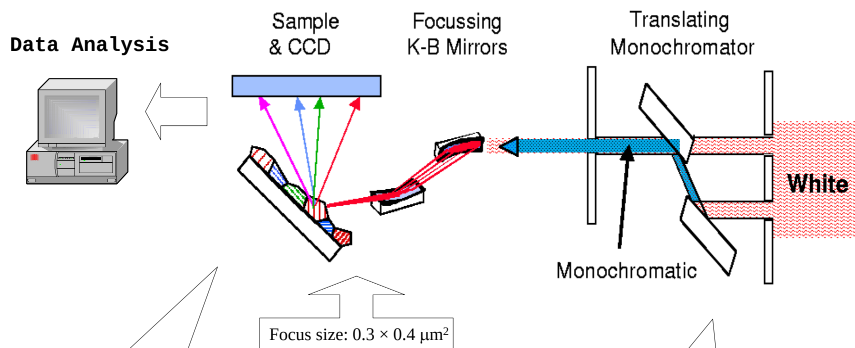
• Insertable scanning monochromator also provides focused monochromatic beam, with a resolution of 1-3 eV over energy range of 7 - 25 keV.

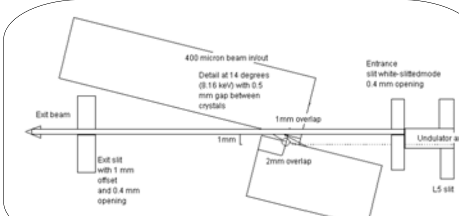
• Polychromatic or monochromatic x-ray beam is focused by a non-dispersive elliptical Kirkpatrick-Baez (K-B) mirror pair. Focal spot: 0.3 × 0.4 μm^2.

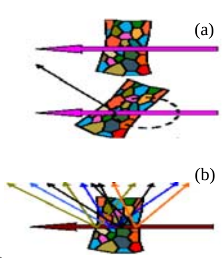
• Data collection and analysis software provides automatic indexation and fitting of the Laue patterns, extraction of crystal orientations and full strain tensors to ~1 × 10^{-4}. The software is being extended to handle new 3D analysis and plastic deformation.

ref: G. E. Ice and B. C. Larson, "Polychromatic X-ray Microdiffraction: Back to the Future to Study Fundamental Issue in Materials Science" APS Research 4, 7-12 (2001).

Schematic of selectable polychromatic/monochromatic x-ray microprobe



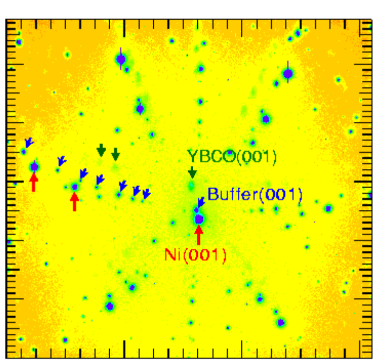




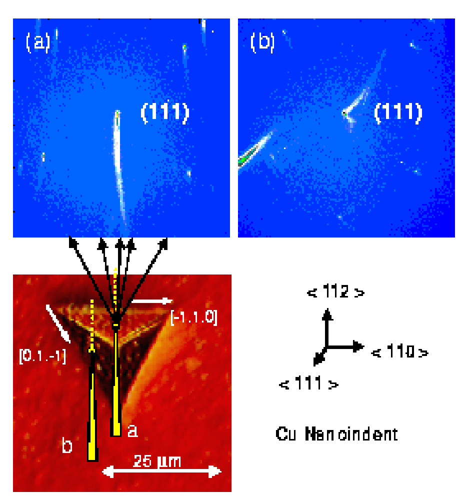
Why polychromatic x-ray microdiffraction?

(a) With a monochromatic beam, each grain in a polycrystalline material has a low probability for Bragg scattering at a given angle. To measure several reflections for a particular grain, the sample is rotated; however, as the sample rotates, the grains that are illuminated by the beam change.

(b) With polychromatic radiation, every grain illuminated generates a complete Laue pattern without sample rotations.



• **Application 1**: X-ray microbeams probe the orientation, strain and local mosaic of a YBCO superconducting film and the underlying buffer layers. The CCD image at the top shows a Laue Diffraction pattern for this multi-layered sample. The intense sharp peaks arise from Ni and the weaker diffuse diffraction peaks arise from the YBCO and buffer layers.



• **Application 2**: Laue diffraction patterns generated by a polychromatic x-ray microbeam probing a nanoindented region of a Cu <111> single crystal. (a) and (b) are images corresponding to microbeam probes at sites 'a' and 'b' in the lower panel. The beam enters the sample at a 45^{o} angle at the positions illustrated in the figure and is attenuated by absorption after penetrating ~30 μm. The dotted lines represent beam propagation beneath the surface.