HARD X-RAY NANOPROBE BEAMLINE

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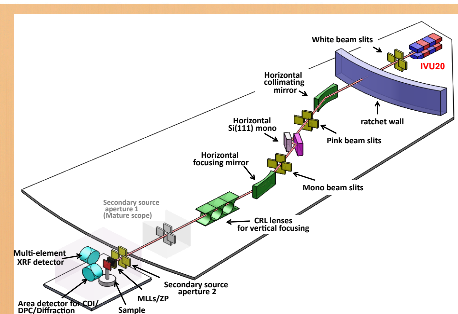
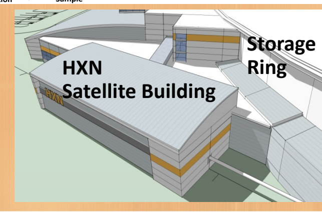
BROOKHAVEN NATIONAL LABORATORY

NATIONAL SYNCHROTRON LIGHT SOURCE II project beamlines • funded by DOE

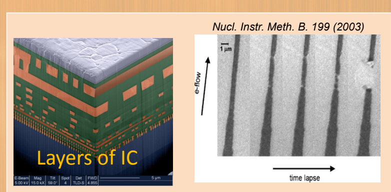
HXN SCIENTIFIC CAPABILITIES

- Unprecedented fluorescence sensitivity: ~1000 cts/s for 1000 Zn atoms with 10nm focus at 10keV.
- Imaging material heterogeneity using multiple contrasts to analyze elemental composition, morphology, oxidation states, crystalline phase, orientation, and strain.
- Structural analysis of buried interfaces of a wide range of "hard" materials to investigate structure-functionality relations.
- Spectro-microscopy analysis on environmental materials will dramatically enhance current understanding of mineral interfacial reactions and bio-geochemical reactions at the nanoscale.
- Capability to imaging and quantify metal distributions in cells and tissues will elucidate metal-mediated biological processes, their linkage to diseases, and lead to potential treatment

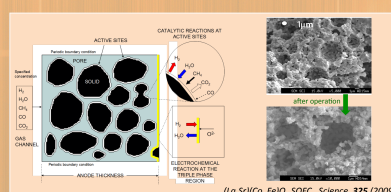




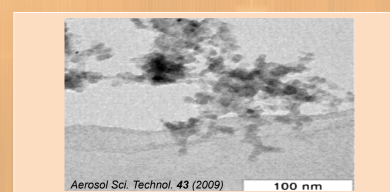
APPLICATIONS



In-situ investigation of electro-migration in the next-generation Integrated Circuits (IC). Parallel mapping of strain and elemental concentration will reveal evolution of strain fields before, during, and after the electro-migration and help mitigate its effects. Electron microscopy techniques require sectioning that greatly modifies the strain field.

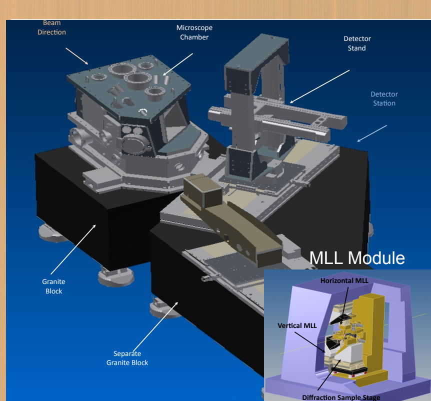


Small changes in the nanostructure of solid oxide fuel cells significantly influences macroscopic properties. Electron microscopy is inadequate for answering critical questions on 3D morphologies, composition, and oxidation states. HXN will allow measurements which correlate the nanostructure and chemical states at triple-phase boundaries with the macroscopic performance.



Nano-scale heterogeneity, reactivity, bioavailability, and toxicity of environmental particulates or atmospheric nanoparticles can be investigated by imaging elemental composition and oxidation states. The results will also have atmospheric implications for climate forcing models, and provide insights into surface chemistry and mechanisms for aggregation and transport.

CAPABILITIES OF THE HXN X-RAY MICROSCOPE



Focusing optic	Spatial resolution	Energy range	Energy resolution	Fluorescence	Fluorescence tomography	XANES	Diffraction
MLL	1-10 nm	10~25 keV	~1e-4	Yes	Yes	limited	Yes
ZP	≤ 30 nm	6~12 keV	~1e-4	Yes	Yes	Yes	Yes

- Highest spatial resolution with scientific flexibility.
- XRF fly-scan with a minimum dwell time of 1 ms per pixel.
  → 5 minutes for 5um x 5um 2D mapping with 10nm pixel size
- Coherent diffraction imaging at higher spatial resolution than the probe size.
- Substantial nano-diffraction capabilities
  → capable of analyzing in-plane and out-of-plane strain for crystalline samples
- Diffraction-contrast imaging with parallel XRF and DPC measurements