

Beamline for Materials Measurement (BMM)



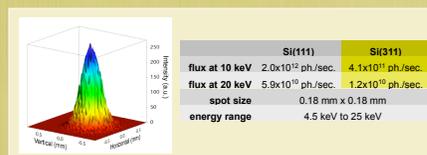
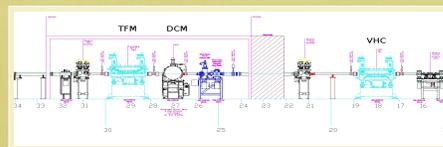
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National Institute of Standards and Technology



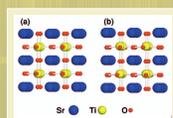
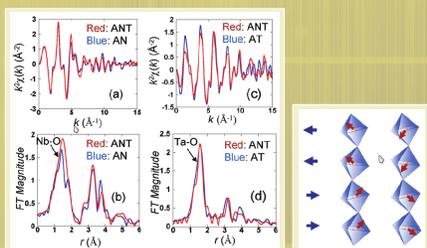
NATIONAL SYNCHROTRON LIGHT SOURCE II type-II beamlines • funded by NIST

TECHNIQUES AND CAPABILITIES

- The mission of BMM is to apply X-ray Absorption Spectroscopy (XAS) and X-ray Diffraction (XRD) to the materials science of important societal challenges in energy, health, environment, and national security; to establish structure/function relationships in advanced materials, often at the nanoscale; to accelerate the development of new materials into devices and systems with advanced functionality; and to promote innovation which enhances US industrial competitiveness.
- BMM uses a three-pole wiggler source along with a paraboloid collimating mirror, a Si (311) monochromator, and a toroidal focusing mirror to provide light to a highly usable end-station.
- The end-station is equipped to provide high-quality, high-throughput XAS coordinated with an eight-circle goniometer for XRD and constant- q spectroscopy measurements such as *reflexafs* or DAFS.



APPLICATIONS

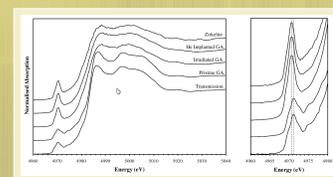
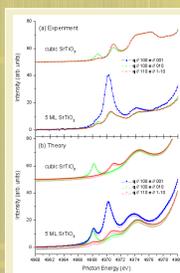


Strain Engineered Electronic Thin Films

Structure/Function Relationships in Electronic Ceramics

Device applications require concurrent optimization of many functional characteristics of materials via modifications of their crystal structures using complex chemistry. We found anomalous XAS results on the temperature dependence of the coordination geometry of $\text{Ag}(\text{Nb}, \text{Ta})\text{O}_3$, the only known system that exhibits large, temperature-stable dielectric constants and modest dielectric loss at microwave frequencies.

Strain engineering via epitaxial thin-film growth effectively tailors the electronic and mechanical properties of a material. Industrial applications range from enhanced electron mobility devices to the realization of ferroelectric memory conjoined with silicon. Strain also alters both the nature and temperature of ferromagnetic, ferroelectric, and superconducting phase transitions. Here we show data and theory for cubic SrTiO_3 and a 2 nm ferroelectric SrTiO_3 thin film grown coherently on Si (001).



Radiation Damage in Nuclear Materials

A study using Grazing Angle XAS on beamline X23A2 was the first to quantify the effect of radiation damage on the coordination environment of key elements in zirconolite ($\text{CaZrTi}_2\text{O}_7$), a model system for actinide immobilization. Analysis of the XANES and EXAFS confirms a transformation to ~100% 5-fold coordination in the damaged surface layer. Grazing angle XAS studies like this will benefit from the higher flux of BMM as well as the superior optics and end-station instrumentation.

NIST INVESTMENT IN BMM



- The BMM monochromator has been procured and tested at NSLS.
- Four- and one-element silicon drift detectors with high-speed, pulse counting electronics are in use at X23A2.
- A low vibration, liquid helium cryostat suitable for use in conventional XAS, glancing angle XAS and diffraction is being commissioned at X23A2.
- Extensive, high-quality XAS hutch instrumentation is in use at X23A2.
- Collimating and focusing mirrors with multiple coatings for extended energy range have been designed and will be procured in FY12.