

WORKSHOP # 9
October 28, 2025
NSLS-II at Brookhaven National Laboratory
NSLS-II Bldg 745, Room 156

Exploring heterogeneity and dynamics of functional materials via advanced X-ray imaging

Organizer: Mingyuan Ge (BNL), Xianghui Xiao (BNL), Eli Stavitski (BNL), Yijin Liu (UT-Austin), Eva Allen (ANL)

Abstract

The workshop aims to explore a wide range of scientific research areas that can benefit from advanced X-ray imaging capabilities to tackle critical challenges across diverse disciplines. We desire to invite researchers to share the scientific needs for new imaging capabilities that are currently underutilized or missing at NSLS-II. The workshop's outcomes will highlight capability gaps and outline the requirements for future NSLS-II advancements, which are essential for maintaining its leadership as a world-class synchrotron facility.

Materials inherently exhibit heterogeneity across various length scales, making it crucial to examine the distribution and evolution of their morphology, chemical composition, and atomic and electronic structures both spatially and temporally to understand the complex relationships between synthesis, structure, and properties. These variations may manifest as phase separations, changes in oxidation states, or localized electronic properties, which often remain undetected in bulk measurements. As a result, fast, microscopic, multimodal characterization under operando conditions is essential. This workshop will bring together beamline experts and leading researchers from diverse fields to discuss the potential of microscopic X-ray techniques and explore how these tools can address major research challenges in areas such as batteries, chemical catalysis, nuclear fuel materials and waste management, geothermal materials, and condensed matter and quantum information systems.

A plenary session will be held to explore how recent advancements in X-ray imaging and spectroscopy can advance research, as well as the challenges that emerging X-ray methodologies could address. The discussion will also cover how advanced statistical methods and machine learning techniques can aid in analyzing multimodal, time-evolving microscopic data, which presents significant challenges due to its high dimensionality and complexity.

The research topics covered in the workshop align with the goals of the U.S. Department of Energy's Basic Energy Sciences (DOE-BES), which supports fundamental scientific research to pave the way for new energy technologies and advance DOE missions in energy, the environment, and national security. Additionally, the workshop's focus is expected to align with the NSLS-II strategic plan and the DOE's strategic framework for "Advancing Scientific Discovery and National Laboratory Innovation."

(<https://www.energy.gov/sites/default/files/2025-01/doe-fy-2022-2026-strategic-framework.pdf>).

Participants in this workshop are encouraged to share their characterization needs and contribute to the development of the workshop summary. The outcomes will be invaluable for NSLS-II in identifying both immediate and long-term needs from the scientific user community and in planning future beamlines.

Start Time (ET)	Title	Speaker (Affiliation)
8:30	<i>Breakfast (coffee, tea, pastries) and Check-In NSLS-II Bldg 745, Room 156</i>	
9:00	Introduction / opening remark	Mingyuan Ge (BNL)
9:10	Overview of Image Program at NSLS-II	Yong S. Chu (BNL)
9:30	X-ray imaging and SAXS/WAXS insight on inspirational insect materials	Konstantin Kornev (Clemson Univ.)
10:00	Full-field synchrotron X-ray imaging techniques for in-situ study of additive manufacturing	Tao Sun (Northwestern Univ.)
10:30	<i>Break (coffee, tea, snacks)</i>	
10:45	3D Synchrotron Characterization of Processes for Cathode Recovery via Direct Recycling	Eva Allen (Argonne National Lab)
11:15	Quantification of Chemical Heterogeneity in Battery Cathodes: Where should we look?	Jordi Cabana (Univ. Illinois Chicago)
11:45	Imaging the Future: Capturing Complex Functional Materials in Action for Energy Applications	Karen Chen-Wiegart (Stony Brook Univ.)
12:15	<i>Lunch Break (provided)</i>	
1:00	Thin film structural reconstruction by scattering contrast	Ruipeng Li (BNL)
1:30	Advances in Hard X-ray Spectroscopy: Techniques and Imaging Applications	Chengjun Sun (Argonne National Lab)
2:00	Understanding heterogeneous dynamics in quantum materials	Yue Cao (Argonne National Lab)
2:30	<i>Break (coffee, tea, snacks)/Group Photo</i>	
2:45	Structure–redox coupling across multi-length scales	Donggun Eum (Stanford Univ.)
3:15	Chemical imaging and microspectroscopy in complex heterogeneous materials: Tender-energy capabilities, advances and future needs	Paul Northrup (Stony Brook Univ.)
3:45	Exploring Hidden Chemical Signatures at the Nanoscale in Complex Environments	Ajith Pattammattel (BNL)
4:15	Discussion	Workshop participants
5:00	Closing remarks	
5:30	Dinner at Bldg 742 (provided)	