doi:10.1017/S1431927622005451
Microsc. Microanal. 28 (Suppl 1), 2022

A Workflow for Improving Nanoscale X-ray Fluorescence Tomographic Analysis

Yanqi Luo [1], Tatjana Paunesku [2], Olga Antipova [1], Yuzi Liu [3], Nestor J. Zaluzec [4], Zichao Di [5], Gayle Woloschak [2,*], Si Chen [1,*]

[1] X-ray Science Division, Argonne National Laboratory, Lemont, IL, USA
[2] Department of Radiation Oncology, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA
[3] Center for Nanoscale Materials, Argonne National Laboratory, Lemont, IL, USA
[4] Photon Sciences Directorate, Argonne National Laboratory, Lemont, IL, USA
[5] Mathematics and Computer Science Division, Argonne National Laboratory, Lemont, IL, USA
* Corresponding author: sichen@anl.gov

Scanning X-ray fluorescence (XRF) tomography provides powerful capabilities to assess the elemental distribution in a three-dimensional (3D) space and differentiate their inter- and intra- cellular interactions in complex biological systems. While there have been significant advancements in instrumentation and reconstruction algorithms [1–3] scanning XRF tomography encounters practical challenges from sample specimens. The range of rotation angles is limited by geometric constraints, involving sample substrates or nearby features blocking or converging into the narrowed field of view.

To overcome this challenge, we propose a reliable workflow to expand the experimental window by incorporating multiscale XRF data collection with an intermediate sample manipulation step utilizing focused ion beam (FIB) between X-ray measurements at different length scales. It not only enlarges tomography data collection using an X-ray nanoprobe, but also provides a statistical assessment by measuring a population of cells at micron-scale and correlating with their nanoscale importances [4].

References:

[1] T. W. Victor, L. M. Easthon, M. Ge, et al., X-ray Fluorescence Nanotomography of Single Bacteria with a Sub-15 nm BeamSci. Rep., 2018, 8, 1–8.
[2] S. Chen, J. Deng, Y. Yuan, et al., The Bionanoprobe: Hard X-ray fluorescence nanoprobe with cryogenic capabilitiesJ. Synchrotron Radiat., 2014, 21, 66–75.
[3] W. van Aarle, W. J. Palenstijn, J. De Beenhouwer, et al., The ASTRA Toolbox: A platform for advanced algorithm development in electron tomographyUltramicroscopy, 2015, 157, 35–47.
[4] This research used resources of both the Center for Nanoscale Materials and the Advanced Photon Source, a U.S. Department of Energy (DOE) Office of Science User Facility operated for the DOE Office of Science by Argonne National Laboratory under Contract No. DE-AC02-06CH11357. Y.L. N.Z. and S.C. acknowledge the support of ANL Laboratory Directed Research and Development PRJ1008073. T.P. and G.W. acknowledge the support of NIH grants U54CA119341 and U54CA199091. S.C. acknowledges the support of DOE grant PRJ1009594.