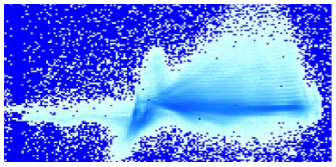

COHERENCE 2024
11th International Conference
on Phase Retrieval
and Coherent Scattering

MAX IV

Contribution ID: **49** Type: **Oral**

Rapid scanning ptychography with 3D real-time position registration at HXN beamline

Monday, 17 June 2024 16:20 (15 minutes)

In the past decades, X-ray ptychography has been demonstrated as a powerful technique of coherent diffractive imaging because of its capability to achieve quantitative phase contrast and nanoscale resolution not limited by the performance of X-ray lenses. It has seen applications in a broad range of research fields from microelectronics to biology [1,2]. However, because ptychography is a scanning-based imaging method and requires high positioning precision of the instruments, the long measurement time and noticeable efforts needed in developing and operating the hardware have been two of the major factors limiting more general utilization of the technique. At the Hard X-ray Nanoprobe (HXN) beamline [3] of NSLS-II in the US, we have developed a system for ptychography and tomography imaging, which enables rapid scanning up to 1kHz speed and simplifies sample preparation and alignment process for more versatile applications.

The Rapid Scanning Microscopy Instrument-II (RASMI-II), being commissioned at the HXN beamline, is the main component of the imaging system which consists of motorized stages for sample and focusing optics. The sample stage uses a precision metrology disc and linear laser interferometers for position referencing, which enables continuous tracking of the sample position in 3D during scanning and sample rotation. This design largely simplifies the sample alignment procedure before measurement and tackles sample drifts during measurement to reduce scan overhead time. By combining the RASMI-II with a fast-response detector and high-speed data collection devices, we were able to push the scanning speed of ptychography measurements to 1kHz in fly-scan mode, which is the fastest frame rate of the detector, thereby achieving tomography measurement time down to 1 hour per sample. We have also developed specialized software and algorithms which incorporates fly-scan trajectories in the iterative phase retrieval process for faster convergence and noise reduction in rapid fly-scan ptychography reconstruction, as well as utilizes 3D position registration data for tomographic alignment and reconstruction.

In summary, the new ptychography and tomography imaging system at HXN beamline based on RASMI-II will provide a platform for high-throughput and versatile nanotomography imaging. Its instrument approach finds a broader potential application for other microscopy beamlines, particularly at the diffraction-limited light sources, where the scanning speed should be commensurate with significantly higher coherent flux.

[1] Holler, M., Guizar-Sicairos, M., Tsai, E.H., Dinapoli, R., Müller, E., Bunk, O., Raabe, J. and Aeppli, G., 2017. High-resolution non-destructive three-dimensional imaging of integrated circuits. Nature, 543(7645), pp.402-406.
[2] Victor, T.W., Easthon, L.M., Ge, M., O'Toole, K.H., Smith, R.J., Huang, X., Yan, H., Allen, K.N., Chu, Y.S. and Miller, L.M., 2018. X-ray fluorescence nanotomography of single bacteria with a sub-15 nm beam. Scientific reports, 8(1), p.13415.
[3] Yan, H., Huang, X., Chu, Y.S., Pattammattel, A., Nazaretski, E. and Ill, P., 2019, September. Hard x-ray nanoprobe: a scanning hard x-ray microscopy beamline offering multi-modal imaging capabilities at 10 nm. In X-Ray Nanoimaging: Instruments and Methods IV (Vol. 11112, p. 1111202). SPIE.

Primary authors: GAO, Zirui (Brookhaven National Laboratory); Dr XU, Weihe (Brookhaven National Laboratory); Dr XU, Wei (Brookhaven National Laboratory); Dr YAN, Hanfei (Brookhaven National Laboratory); Dr GARVRILOV, Dmitri (Brookhaven National Laboratory); Dr XU, Huijuan (Brookhaven National Laboratory); Dr MICHELSON, Aaron (Brookhaven National Laboratory); Dr CHU, Yong S. (Brookhaven National Laboratory); Dr NAZARETSKI, Evgeny (Brookhaven National Laboratory); Dr HUANG, Xiaojing (Brookhaven National Laboratory)

Presenter: GAO, Zirui (Brookhaven National Laboratory)

Session Classification: Instrumentation and method development - S1