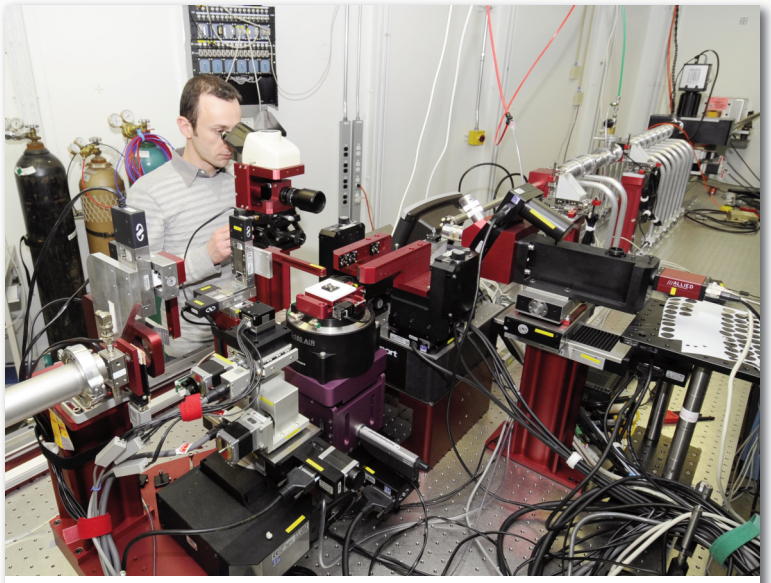
The Advanced Photon Source

A New TXM Instrument to Address Future Challenges in Nanoscience at the APS

A new dedicated transmission x-ray microscope (TXM) at Sector 32 of the U.S. Department of Energy Office of Science's Advanced Photon Source has recently been commissioned and made available for general-user operations, replacing a former first-generation commercial system.

The new instrument, situated in the 32-ID-C research station, provides superior analytical imaging performance and *in situ* capabilities. It was developed to explore and better understand nanomaterials in the fields of energy storage, microelectronics, and nanoporous materials functions as well as the life, Earth, and environmental sciences.

The analytical techniques currently available include absorption, Zernike-type phase contrast and x-ray absorption near edge structure (XANES) tomography.



Advanced Photon Source physicist and beamline scientist Vincent De Andrade, who is in charge of the TXM in the 32-ID-C research station, during commissioning of the instrument. The setup consists in a condenser optic (mono-capillary, not installed whn this photo was taken) to focus x-rays at the sample location while defining the size of the illumination; a high-stability sample stage; and an objective lens (Fresnel zone plate) forming a magnified image of the sample on a charge-coupled device-based detector located between 3 m and 4 m downstream for magnification purposes.

One of the key design features of the new TXM is the ability to perform routine operations with a spatial resolution of 20 nm, making this instrument the highest resolution hard x-ray full-field imaging system at the Argonne National Laboratory Advanced Photon Source. The energy range has also been expanded. The TXM, equipped with an undulator and a fixed exit double-crystal monochromator (Si 111), now operates in the range from 8 keV to 15 keV. The low-energy limit will be pushed below 5 keV during the next several months, enabling, for instance, spectroscopy at the Fe K-edge. The available set of optics provides fields of view ranging from 100 μm to 20 μm with spatial resolutions of 60 nm and 20 nm. The Fresnel zone plate geometry also offers working distances from 20 mm to 70 mm, allowing the TXM to accommodate a variety of sample environments. Electrical and high-pressure fluid feed-throughs were integrated into a high-accuracy, air-bearing rotary stage to facilitate a wide range of *in situ* environmental controls, including temperature, pressure, and chemical bath without affecting the three-dimensional nano-computed tomography imaging performance.

The instrument is supported by several key R&D activities at the Advanced Photon Source, such as the fabrication of new zone plates in the framework of the multi-bend achromat lattice upgrade planned for the facility. A more complete set of zone plates, which will provide a broader range of spatial resolution as well as a 16-nm Δrn zone plate, are in production. The TXM will directly benefit from these R&D programs by achieving 10-nm spatial resolution and an upper energy limit of 20 keV, which will enable tomography of denser materials within the next three years.

The TXM is also the centerpiece for a program focusing on scientific software development of methods for merging multilength scale and multi-modality data. The outcome of this activity is the software framework called tomoPy (http://www.aps.anl.gov/tomopy/) an open source Python-based toolbox for the analysis of synchrotron tomographic data that has the goal of unifying the effort of different facilities and beamlines performing similar tasks.

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Call for APS General-User Proposals

The Advanced Photon Source is open to experimenters who can benefit from the facility's high-brightness hard x-ray beams.

General-user proposals for beam time during Run 2015-1 are due by Friday, October 31, 2014.

Information on access to beam time at the APS is at http://www.aps.anl.gov/Users/apply_for_beamtime.html or contact Dr. Dennis Mills, DMM@aps.anl.gov, 630/252-5680.

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