Argonne NATIONAL LABORATORY

News Release

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Argonne's Hard X-ray Nanoprobe provides new capability to study nanoscale materials

Novel microscopy tool provides highest resolution for hard X-rays

ARGONNE, Ill. (June 24, 2008) – The Center for Nanoscale Materials' (CNM) newly operational Hard X-ray Nanoprobe at the U.S. Department of Energy's (DOE) Argonne National Laboratory is one of the world's most powerful X-ray microscopes.

It has been designed to study novel nanoscale materials and devices aimed at, for example, harvesting solar energy more efficiently, providing more efficient lighting or enabling next-generation computing. The weak interaction of hard X-rays with matter allows researchers to penetrate into materials, look through process gases and study sub-surface phenomena. At the same time, this property also has made fabrication of efficient X-ray optics difficult, limiting the degree to which hard X-rays can be focused.

Using advanced X-ray optics called Fresnel zone plates – similar in appearance to the large Fresnel lenses used to reflect light in lighthouses – along with a laser-based nanopositioning system, Argonne is able to focus X-rays to the smallest spot yet achieved with this type of illumination source. The microscope combines scanning-probe and full-field transmission imaging to create both three-dimensional visualizations of complex systems and devices as well as to perform sensitive quantitative analysis of elemental composition, chemical states, crystallographic phase and strain.

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"It's the highest resolution microscope of its type in the world right now," acting CNM Division Director Stephen Streiffer said. "The Nanoprobe is one of the tools that make the CNM unique."

The Nanoprobe uses X-rays with photon energies between 3-30 kiloelectron volts to produce images with initially 30 nanometer resolution – roughly the size of 100 atoms. As X-ray optics continue to improve and novel X-ray optics are developed, it is anticipated that significantly higher spatial resolution will be reached over the lifetime of the Nanoprobe.

The Hard X-ray Nanoprobe was designed, constructed and is operated in partnership between the CNM and the X-ray Science Division of the Advanced Photon Source (APS) at Argonne. The CNM pursues the development and characterization of novel nanoscale materials and devices. The capabilities of Argonne's Advanced Photon Source play a key role in that their hard X-rays, used by the Nanoprobe beamline, provide unprecedented capabilities to characterize very small structures.

“The instrument allows characterization of nanoscale materials and devices in previously unavailable detail," said Nanoprobe Beamline director Jörg Maser, "and is particularly well suited for the study of buried structures, in real world environments and for dynamics."

The Nanoprobe became operational in October of 2007 and is open to all science users based on peer review under the user programs of the APS and the CNM. The CNM is a national user facility, providing tools and expertise for nanoscience and nanotechnology research.

Funding for this research was provided by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences. The mission of the Basic Energy Sciences program – a multipurpose, scientific research effort – is to foster and support fundamental research to expand the scientific foundations for new and improved energy technologies and for understanding and mitigating the environmental impacts of energy use.

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