news bureau
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN





# X-ray microscope can image crystalline grains in three dimensions

James E. Kloeppel, Physical Sciences Editor
(217) 244-1073; kloeppel@uiuc.edu

3/18/02

CHAMPAIGN, Ill. — A lensless X-ray microscope that can create three-dimensional images of micron-size samples has been developed by scientists at the University of Illinois. The instrument can be used in metallurgical and semiconductor applications, and for studying the early growth stages of protein crystals.

Unlike conventional radiography, which looks at the variation in X-ray absorption (between bones and soft tissue, for example), the new imaging method is based on coherent X-ray diffraction. The technique can image microscopic crystals embedded in solids or liquids that are inaccessible to electron microscopy.

"Coherent X-ray diffraction, coupled with our imaging capability, offers considerable potential for studying nanocrystalline materials, including proteins," said Ian Robinson, a professor of physics and a researcher at the Frederick Seitz Materials Research Laboratory on the UI campus. "The penetrating power of a beam of X-rays allows us to peer beneath the surface of the material and see features buried inside."

In place of an objective lens, the X-ray microscope uses computer inversion of the diffraction pattern to produce an image. The computer algorithm is similar to that used in "CAT-scanning" tomography for medical imaging.

To create an image, Robinson and his colleagues – graduate students Garth Williams, Mark Pfeifer and Sebastien Boutet with visiting scientist Ivan Vartanyants – illuminate a sample with a coherent beam of X-rays generated at the Advanced Photon Source, a synchrotron radiation facility located at Argonne National Laboratory near Chicago. The diffracted X-rays are collected by a CCD (charge-coupled device) detector and converted into signals that can be read by a computer.

As the sample is rotated, a series of two-dimensional

Editor's Pick

- Small research big on campus (4/5/02)
- Illinois flash economic index indicates state still in slump (4/2/02)
- Distinguished Cal-Tech astronomer to present public talk April 24 (4/1/02)
- Robert F. Kennedy Jr., author Dave Eggers to speak at town meeting April 6 (3/29/02)
- Jordanian prince to discuss future of Middle East on April 10 (3/25/02)
- State finals of Illinois Science Olympiad to be held April 6 (3/22/02)
- Fourth Roger Ebert Film Festival to run April 24-28 (3/11/02)
- 

On the Job: Don Chambers

diffraction patterns is created, which can be reconstructed into a high-resolution, three-dimensional image. Such images can be extremely useful to structural biologists studying the growth of protein crystals.

"The preparation of protein crystals for X-ray crystallography can be a very challenging and time-consuming task," Robinson said. "Much of the effort that goes into solving the structure of a protein actually goes into finding the ideal growth conditions and obtaining the crystals."

One of the bottlenecks in growing crystals, he said, is that the growth mechanisms, themselves, are not well understood. To facilitate the preparation of protein crystals, scientists must better understand the mechanisms involved in the nucleation process that occurs in the early stages of crystal growth.

"One way to accomplish that is to use the X-ray microscope to look at the nucleation stage of the protein aggregate as it transforms into a crystal," Robinson said. "This could give valuable information on the structure of critical nuclei and provide new insight into the nucleation process."

Robinson will describe the new X-ray imaging technique at the American Physical Society meeting in Indianapolis. His talk will take place Monday afternoon, March 18, in Room 201 of the Indiana Convention Center.

The National Science Foundation, U.S. Department of Energy and the State of Illinois funded the work.

News Bureau, University of Illinois at Urbana-Champaign
807 South Wright Street. Suite 520 East, Champaign, Illinois 61820-6219
Telephone 217 333-1085, Fax 217 244-0161