NEWS

Published online: 14 August 2002; | doi:10.1038/news020812-5

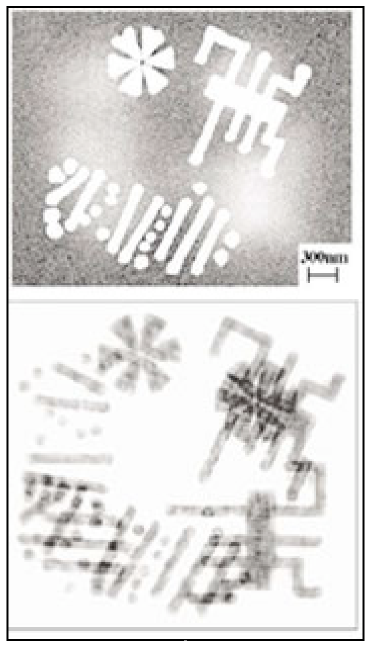
X-rays scratch below the surface

Philip Ball

A new X-ray microscope sees clearer and deeper than ever before.

Scientists have made an important step towards developing a camera that takes atomic-scale snapshots. They have created a microscope that forms three-dimensional images using X-rays[1].

At present, the new microscope can reveal structures no more than eight nanometres (millionths of a millimetre) across. Atoms are typically just a few tenths of a nanometre across. But using brighter X-ray beams or longer exposure times should give atomic-scale resolution, say Jianwei Miao of Stanford University, California, and his colleagues, who developed the new device.



X-ray vision: images from the new microscope (bottom) reveal depths that electron microscopes miss (top).

Scientists have long dreamed of the X-ray microscope. Such a device could show any arrangement of atoms in three dimensions, because X-rays have a wavelength similar to the size of atoms.

There are already several ways of seeing atoms, but each has limitations. Transmission electron microscopy can resolve individual atoms only for samples about 50 nanometres thick. Scanning probe microscopes can reveal individual atoms, but only at a material's surface.

Crystallography reveals atoms' three-dimensional patterns by bouncing waves off a sample and looking at how they interfere with each other, a phenomenon called diffraction. But this only

RELATED STORIES

Pin-sharp protein photos
14 December 2000
The molecular torch
18 May 2000
Atomic billiards
13 April 2000

EXTERNAL LINKS

Virtual Library: Microscopy

people in Vietnam
13 August 2004
Tidal flow to power New York City
13 August 2004
Mars rover snaps panoramic view
12 August 2004
Method boosts bone-marrow transplants
12 August 2004
Gravity equations give rise to measles model
12 August 2004
WHO to define ideal for child growth
11 August 2004
UK gives go-ahead to therapeutic cloning
11 August 2004
Reefs get global warming lifeline
11 August 2004
Future looks bleak for powerless Hubble device
11 August 2004
Gene therapy cures monkeys of laziness
11 August 2004
Doped athletes flex muscles against drug company
11 August 2004
Climate predictions gain surer footing
11 August 2004
Tyrannosaurs had teenage growth spurt
11 August 2004

works for crystals, which have a regular arrangement of atoms. Many structures aren't like this, including living cells, polymers and glasses.

First sight

Miao and his colleagues' technique is a kind of hybrid of diffraction and microscopy. It involves firing a beam of coherent X-rays, in which all the waves rise and fall in step, at a sample and looking at the diffraction pattern in the reflected beam.

The pattern forms from X-rays bouncing off only a very small region of the sample. So the image shows local structure, as in a microscope, rather than some average structure, as is the case in crystallography.

Miao's team first reported this sort of X-ray microscopy[2]in 1999. But at the time it revealed only two-dimensional structures, with a resolution of about 70 nm.

Now the researchers can see two-dimensional structures about ten times smaller than this. And they can map out three-dimensional structures with a resolution of around 50 nm. For example, they could see two different, complex patterns in nickel films stacked 1,000 nm apart.

One way of improving the resolution would be to use longer X-ray exposures. This would work for robust substances such as semiconductors, but it would fry cells. Deep-freezing samples would help, say the researchers. Or using the much brighter beams of X-ray lasers, which are currently in development.

Top

References

1. Miao, J. et al. High-resolution 3D x-ray diffraction microscopy. *Physical Review Letters* **89,** 088303, (2002). | Article | ChemPort |
2. Miao, J. et al. Extending the methodology of X-ray crystallography to allow imaging of micrometre-sized non-crystalline specimens. *Nature* **400,** 342, (1999). | Article | ISI |

Top

news@nature.com

Home | News | Features | Columns & blogs | Archive | Specials | In focus | Stories by subject |
My news | Biotechnology | Careers | Drug discovery | Earth and environment | Medical Research | Physical sciences |
Feedback | About this site | About us | For librarians

ISSN: 1744-7933