Web alert

Atomic force microscopy

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If you wish to view atoms, investigate molecular forces, image hydrated biological specimens or even move molecules around, then the atomic force microscope (AFM) is the tool for you. Rapid developments are being made in this relatively new area of instrumentation, but patience and persistence are definitely required; it is certainly not a 'plug in and go' tool.

AFM is one of a family of techniques collectively known as scanning probe microscopy (SPM). These techniques seek to measure various quantities, for example, tunnelling current, force and thermal conductivity, relating to the atomic surface of organic and inorganic samples. The scanning tunnelling microscope (STM) was the first example of this kind of tool; you might recall researchers at IBM writing the company name in atoms. The AFM can be used in several modes to map sample surfaces by monitoring the force between the probe and surface atoms. Force measurements also enable molecular bonds to be examined.

The 'scanning probe microscopy teaching site' at the University of Nottingham (http://pharm6.pharm.nottingham.ac.uk/AFM/map.htm) provides a good introduction to the SPM. Here the differences between the operating modes of AFM are explained clearly with the aid of animations. The University of Bristol, Department of Physics scanning probe microscopy site (http://teddy.phy.bris.ac.uk/SPM/) and a teaching site provided by the Department of Chemistry and Biochemistry at the University of Guelph (http://www.chembio.uoguelph.ca/educmat/chm729/afm/firstpag.htm) are also useful starting points to learn about AFM.

For a more comprehensive guide to using AFM for both topography mapping and making force measurements, see chapter 1 of *A Practical Guide to Atomic Force Microscopy*, which is fully available online (http://www.park.com/spmguide/contents.htm). Those interested in more technical operational issues, including the characteristics of the probes, will find chapters 2 and 3 of *A Practical Guide to Atomic Force Microscopy* and the Atomic Force Microscopy page on the Imperial College Physics Department site (http://www.sst.ph.ic.ac.uk/photonics/intro/AFM.html) useful.

Many images produced by the AFM can now be found on the internet but few are accompanied by details of the mode of operation of the microscope, specimen preparation or image processing procedure. As with any new technology, the finer details of procedures developed in the research laboratory to study a particular specimen are closely guarded secrets.

Several websites mentioned in this article have scanning probe microscopy galleries showing a variety of AFM images of biological materials including the surfaces of proteins, DNA, myosin, red blood cells and viruses. Other websites with interesting molecular material include the Institute of Food Research (http://ifr.bbsrc.ac.uk/fqm/spm) and the University of Surrey School of Mechanical and Materials Engineering (http://www.surrey.ac.uk/MME/Research/SPM/12-1.html). The surface topographies of molecular lattices have been viewed at atomic resolution as shown by the images of the alkane crystal and graphite lattice on the University of Bristol scanning probe microscopy site.

At the same site, animation tools have been used to give the observer a 'fly-by' view of the topography of a chromosome. Cell movement has also been recorded for cells with velocities much slower than the scan rate of the microscope. At the Digital Instruments Nanotheatre (http://www.di.com/), a sequence of images from a moving endothelial cell can be seen, and, with the aid of an appropriate viewer, time lapse images of MDCK and R5 cells can be viewed on the Hoh Lab home page at the Johns Hopkins University, Baltimore (http://hohlab.bs.jhmi.edu/).

Although the principle of the AFM is relatively simple, using it to investigate bonding and other forces requires diligence and perseverance. Examining bonding between two molecules requires the probe to be coated in molecules of one type and the sample to consist of molecules of the second type. Force curves for a myosin molecular motor have been produced using the AFM in its lateral force mode. The procedure used in this investigation of actin–myosin binding is described on the website of the Local Probes Group at the European Molecular Biology Laboratory in Heidelberg (http://www.embl-heidelberg.de/ExternalInfo/hoerber/index.html).

If you would like to find out more or do some follow-up reading, you can also find useful links on the Microscopy Society of America homepage (http://www.msa.microscopy.com) or have a look at the *Biophysical Journal* (http://www.biophysj.org), where AFM research is often published.

The sites referenced here show that AFM can generate spectacular and aesthetically pleasing images while producing results at the cutting edge of atomic and molecular science.

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