Atomic, Molecular, and Optical Science

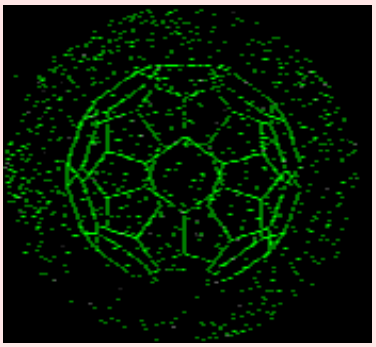
Addressing Fundamental Questions and National Needs

2. Carbon Fullerenes

- The element carbon, which is essential to all life, comes in two common forms: diamond, a three-dimensional structure, and graphite, made of two-dimensional flat sheets.
- The carbon atoms in a graphite sheet are arranged in a regular hexagonal pattern. Incorporating pentagons or heptagons in place of some of the hexagons causes the flat sheets to curve, forming entirely new forms of carbon known as fullerenes.
- Among these intellectually and technologically interesting new structures, all discovered only in the last few years, are buckyballs, nanotubes, and nanoropes.

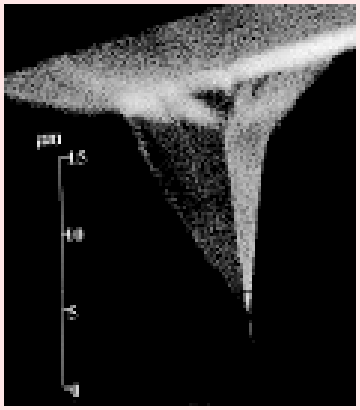
Buckyballs

The fullerene revolution began with the discovery of the buckyball (C_{60}), formed of 60 carbon atoms arranged in a hollow "soccer ball" shape. Its discoverers were awarded the Nobel Prize in 1996. The hollow inside a buckyball can be filled with other atoms or molecules, forming a "molecular pill" with potential applications in medicine and elsewhere.



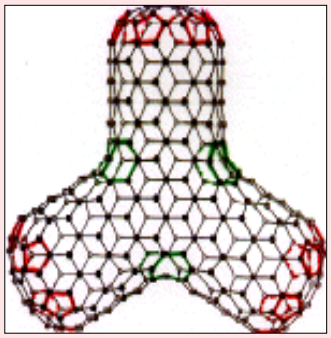
Nanotubes

Multiwalled nanotubes of nested carbon cylinders are also of great interest. Nanotips made from multiwall nanotubes make the best tips for scanning probe microscopes, instruments that are essential for the development of nanotechnology.

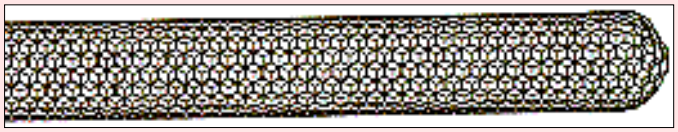


Branches and Caps

Branches and caps can be added to nanotubes by incorporating heptagons and pentagons into the structure. These new forms of carbon are the building blocks of several emerging nanotechnologies.



Nanotubes



Single-walled carbon nanotubes can act as filters, separating molecules by size. The (10,10) type shown here is a metal 100 times stronger than steel, strong enough to make science fiction's "elevator to space".

This is one in a series of one-page handouts based on the National Research Council report *Atomic, Molecular, and Optical Science: An Investment in the Future* (National Academy Press, Washington, D.C., 1994). For more information on this report, look on the World Wide Web at http://www.nap.edu/readingroom/books/amo or contact the NRC Board on Physics and Astronomy on the Web at http://www.nas.edu/bpa, by email at bpa@nas.edu, or by telephone at 202-334-3520.