Buckytubes

The allotropes of carbon — diamond, graphite and buckminsterfullerene (bucky balls) — are well known. Now scientists are working on **buckytubes** (Figure 1). Buckytubes are based on elongated tubes formed from sheets of hexagonally-linked carbon atoms, capped at both ends with carbon pentagons. These tubes can be as little as 1 nanometre (10^{-9} m) in diameter. Although scientists have known about buckytubes since the 1960s, it was only in 1992 in Japan that Sumio Iijima first managed to make them in large quantities.

The tubes form without defects in their structure. This is unlike any other known material — steel, for example, fails at about 1% of its theoretical breaking strength due to defects in its structure. They can be manipulated chemically and physically and have unique properties which cannot be bettered by any known substance. They offer amazing possibilities for creating future nanoelectronic devices, circuits and computers.

Properties of buckytubes

- **Electrical conductivity** — they are as good at conducting as metals — better than any other polymer. They can carry the highest current density of any known material. A different form of buckytube acts like a semiconductor.
- **Thermal conductivity** — they are twice as conductive as diamond — previously the best-known thermal conductor.
- **Mechanical properties** — they are the stiffest known fibre — stronger even than high tensile steel.
- **Chemistry** — they have been filled with molten lead, leading to the idea of molecular wires. They have also been filled with proteins and catalysts. Substances can be chemically bonded to their ends or to their sides, leading to the possibility of all sorts of new technological applications in the future.

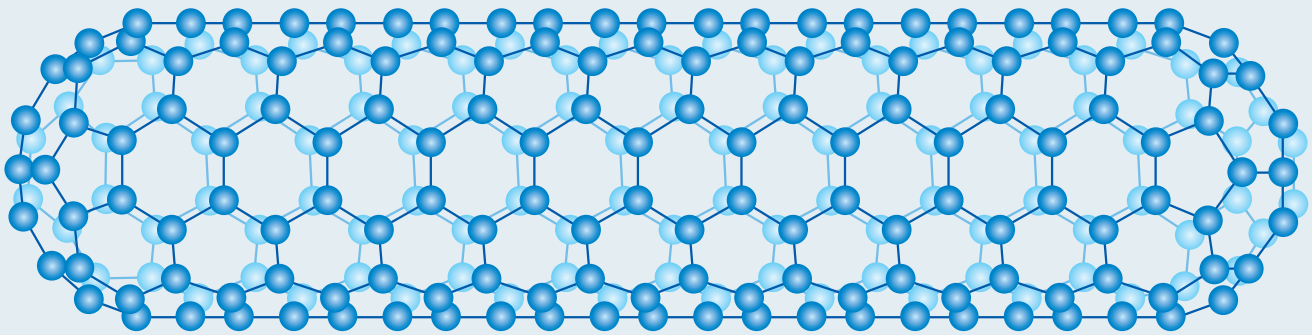
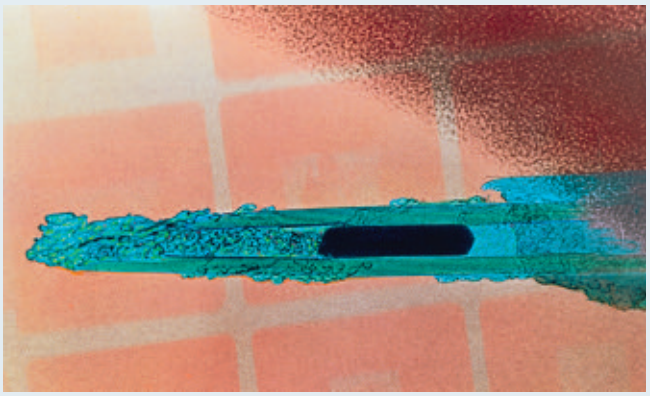


Figure 1 *Buckytube*



Dr Peter Harris/SPL

Coloured transmission electron micrograph of the world's smallest bar magnet — a single crystal of nickel inside a nanotube

Cylinders

In addition to having a single cylindrical wall, nanotubes can be made which have multiple walls — cylinders inside other cylinders. Sheets can also wrap around each other in spiral fashion to form a hollow cylinder with a core of up to 15 nanometres wide.

Activities

- Move a buckytube around in three dimensions at: www.3dchem.com/molecules.asp?ID=104
- Find out more about buckytubes at: www.pa.msu.edu/cmp/csc/nanotube.html