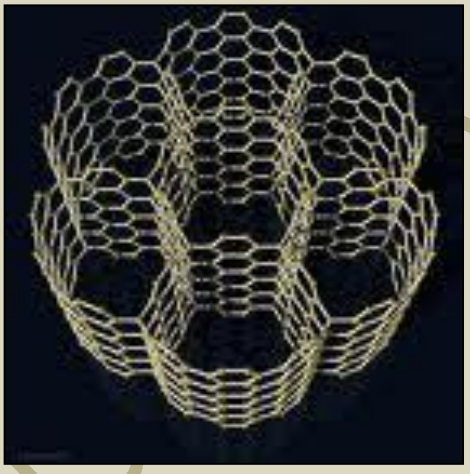
NANOTUBES EXPLAINED

Nanotechnology is set to turn the engineering, textile, electrical, electronic and medical industries on their heads.



A nanotube is a cylinder made up of atomic particles and has a diameter that is as small as one billionth of a metre: a nanometre. Between 10,000 and 50,000 nanotubes can fit across the diameter of a human hair.

A carbon nanotube is a cylinder with a wall formed of bonded graphite atoms.

It's hard to imagine that a tiny cylinder of graphite – the soft carbon that flakes off a pencil tip on to paper when you write with it – could turn out to be the strongest fibre known: up to 100 times stronger than an equivalent weight of steel. It's been suggested that a strand of CNT could become a 'space elevator': connecting a geostationary space station with Earth.

The immense strength of CNT comes from the shape of the tiny tubes, greatly improving on carbon fibre products that employ much larger strands. Shape is everything in the nano-world: remember that graphite and diamond are formed from identical carbon atoms, but they're differently arranged.

CNTs also have very interesting electrical properties: a nanotube can behave as either a semi-conductor or a conductor, depending on exactly how the tube is formed, but it can even be both, at different points along its length. If you're into quantum mechanics and Shottky barriers you'll know where that can lead with electrical engineering.

Inside the humble vehicle battery, nanoparticles can be added to the electrolyte and the electrodes, greatly increasing active surface areas and improving current flow, while reducing charge time. It's also possible that future CNTs will be used in nickel carbon nanotube Ni/CN batteries, or formed into capacitor stacks that store electrical charge and replace chemical-reaction batteries.

Many other applications have been proposed for CNTs, including super-light, super-strong electrical transmission wires; higher-strength composites; and nanometre-sized semiconductor devices.

CNT membranes have been suggested for water filtration, desalination and demineralization. Getting salt out of water is an expensive process that's normally done by reverse osmosis, using relatively restrictive membranes and a great deal of pressure. Less restrictive nanotube membranes have the potential to reduce the energy costs of desalination by more than half.

Bucky-Balls

Ball-shaped nanotube structures known as 'bucky-balls' are named after American architect R. Buckminster Fuller who designed a geodesic dome with the same fundamental symmetry .Since their discovery in 1985 bucky-balls have intrigued scientists, who continue to look for uses for these unique molecules.

The most common bucky ball is known as C_{60}, because it's a structure formed of 60 carbon atoms, linked in a 20-hexagon and 12-pentagon pattern – just like a soccer ball. C_{60} and larger bucky-ball carbon molecules occur naturally in limited quantities but can be synthesised.

Bucky-balls are enormously resistant to compression, becoming much harder than diamond when reduced in size and are hollow, providing a tempting space for lighter atoms to be placed. Bucky-balls may prove to be ideal storage places for hydrogen gas molecules in fuel-cell-powered vehicles, offering secure fireproof micro-storage until the gas is required for cell consumption.

There's already an acronym for the process of electric field controlled hydrogen storage in carbon nanotubes: FHSN (Field controlled Hydrogen Storage Nanoparticles).

There are companies currently developing solar and energy storage products, using carbon nanotubes and bucky-balls. If the replacement for fossil vehicle fuel is to be hydrogen, nanotechnology may increase the efficiency of solar cells, allowing these photovoltaic plates to supply much greater quantities of electricity – enough to electrolyse water and produce hydrogen in commercial quantities.

CNT Credits

Whenever there's a scientific discovery as significant as nanotubes and bucky-balls there's accompanying controversy about who actually did the discovery.

Sumio Iijima is a Japanese physicist, often cited as the discoverer of carbon nanotubes. Although carbon nanotubes had been observed prior to his 1991 scientific paper, the unprecedented interest in carbon nanostructures can be traced to that date.

Probably the first scientists to come across CNTs were L V Radushkevich and V M Lukyanovich, who published clear images of 50-nanometre-diameter tubes made of carbon in the Soviet Journal of Physical Chemistry, way back in 1952. The Cold War meant that their discovery never made it into global scientific publications and so its significance remained hidden from researchers until relatively recently.

Bucky-balls were discovered in 1985 by scientists Robert Curl, Harold Kroto and Richard Smalley and for which they were awarded a Nobel Prize.

