



Nanotubes

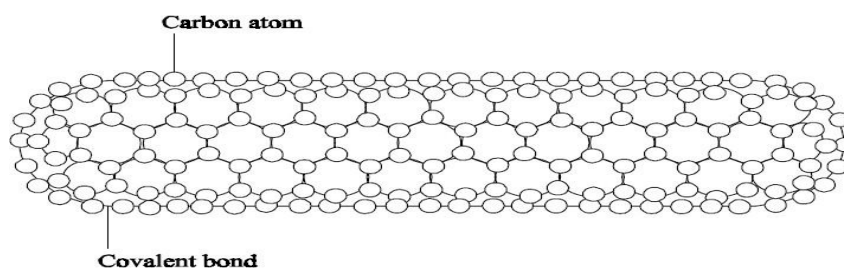
- Nanotubes are tube like structures with diameter of 1-100nm and a length of few nm to microns.
- Nanotubes consists of tiny cylinders of carbon and other materials like boron nitride. Nanotubes may be organic (or) inorganic.

Examples:

1. Carbon nanotube
2. Silicon nanotube
3. DNA nanotube
4. Boron nitride nanotube

1. Carbon nanotubes (CNTs)

- Carbon nanotubes are allotropes of carbon with a nanostructure having a length-to-diameter ratio greater than 1,000,000. When graphite sheets are rolled into a cylinder, their edges joined and form carbon nanotubes i.e., carbon nanotubes are extended tubes of rolled graphite sheets.
- Nanotubes naturally align themselves into “ropes” and held together by vanderwaals forces.
- But each carbon atoms in the carbon nanotubes are linked by the covalent bond.



Single walled carbon nano tubes (SWCNT)

Structure (or) types of carbon nanotubes

- Depending upon the way in which graphite sheets are rolled, two types of CNTs are formed.

(i) Single - walled nanotubes (SWNTs)



- SWNTs consist of one tube of graphite. It is one-atom thick having a diameter of 2 nm and a length of 100 μm .
- SWNTs are very important, because they exhibit important electrical properties.
- It is an excellent conductor.
- Three kinds of nanotubes are resulted, based on the orientation of the hexagon lattice.

(a) Arm-chair structures: The lines of hexagons are parallel to the axis of the nanotube.

(b) Zig-zag structures: The lines of carbon bonds are down the centre.

(c) Chiral nanotubes: It exhibits twist or spiral around the nanotubes.

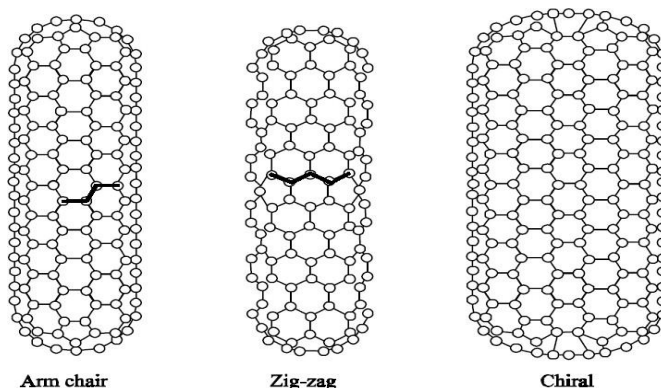
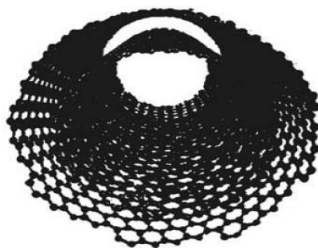


Fig. 5.8a Structure of Single walled carbon nanotubes

- It has been confirmed that arm-chair carbon nanotubes are metallic while zig-zag and chiral nanotubes are semiconducting.

(ii) Multi - walled nanotubes (MWNTs)

- MWNTs (nested nanotubes) consist of multiple layers of graphite rolled in on themselves to form a tube shape.
- It exhibits both metallic and semiconducting properties. It is used for storing fuels such as hydrogen and methane.



Multi walled Carbon Nanotubes (MWCNT)

SYNTHESIS OF CARBON NANOTUBES

- Carbon nanotubes can be synthesised by any one of the following methods.
 1. Pyrolysis of hydrocarbons.
 2. Laser evaporation.
 3. Carbon arc method.
 4. Chemical vapour deposition.

Properties of CNT's

- CNTs are very strong; withstand extreme strain in tension and possess elastic flexibility.
- The atoms in a nano-tube are continuously vibrating back and forth.
- It is highly conducting and behaves like metallic or semiconducting materials.
- It has very high thermal conductivity and kinetic properties.

Uses of CNT's

- It is used in battery technology and in industries as catalyst.
- It is also used as light weight shielding materials for protecting electronic equipments.
- CNTs are used effectively inside the body for drug delivery.
- It is used in composites, ICs.