Carbon NanoTubes (CNT)

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Allotropes of Carbon

(a). Diamond

(b). Graphite

(c). Lonsdaleite

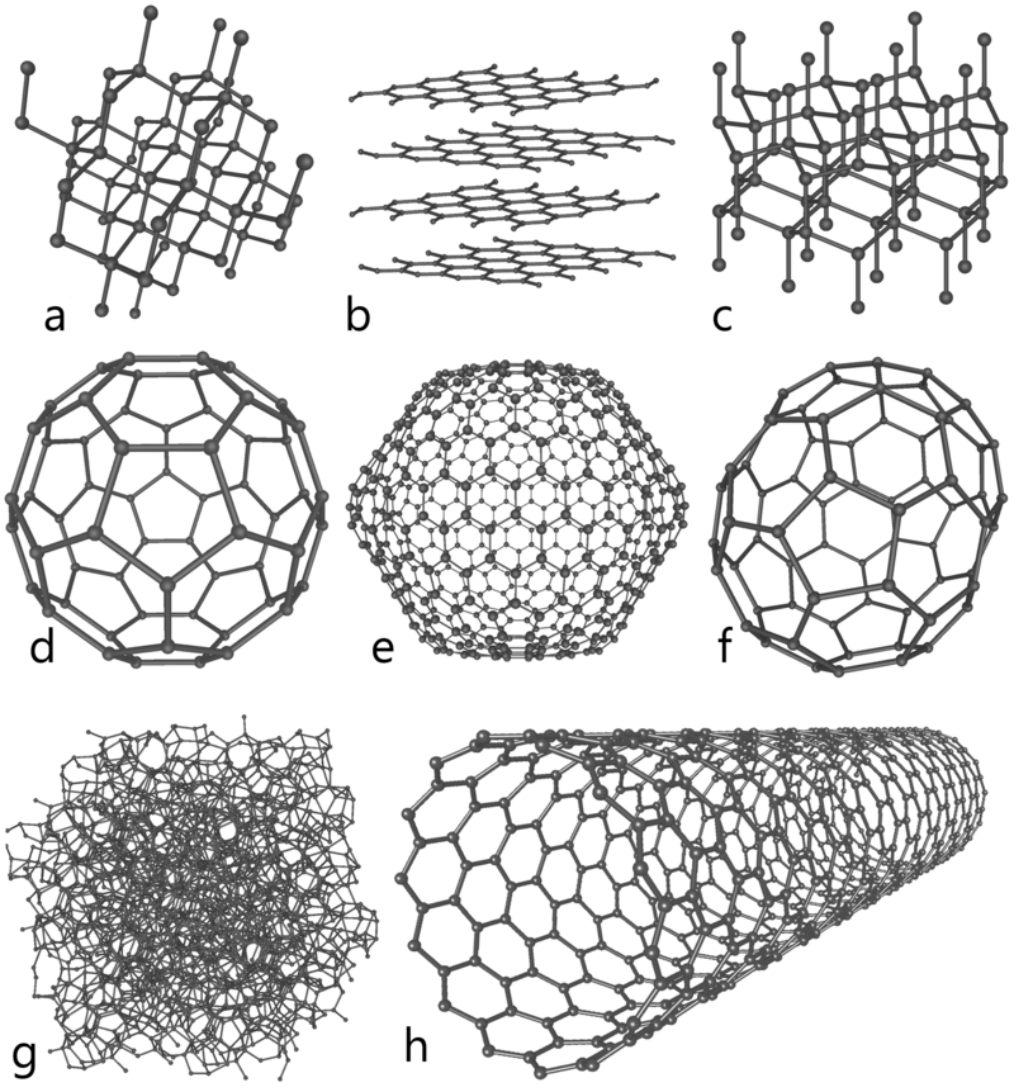
(d). C_{60} Fullerene

(e). C_{540} Fullerite

(f). C_{70}

(g). Amorphous carbon

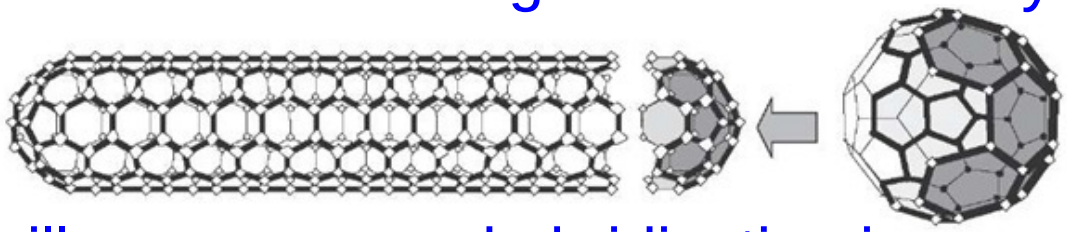
(h). Carbon nanotube



Thanks wikipedia

Carbon NanoTube (CNT)

- Graphite: Each carbon linked to other by (sp^2 hybridization) covalent bonds and forms hexagonal rings in the planar structure (Graphene).
- Carbon nanotube is imagined to be obtained in the cylindrical form by rolling graphene sheet and closing both the ends by fullerene hemispheres.

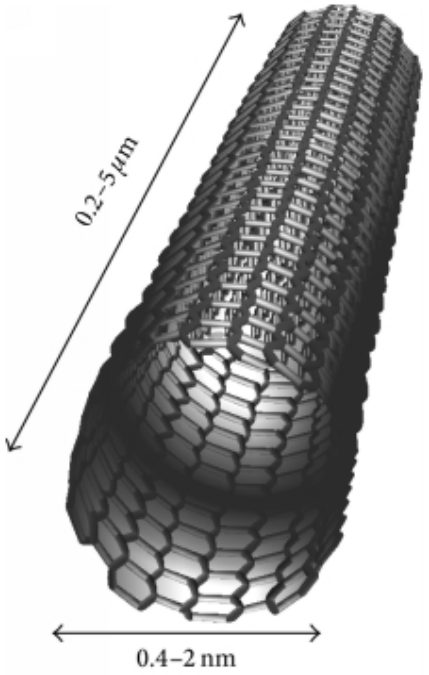


- The circular curvature will cause σ - π rehybridization in which the 3 σ bonds are slightly out of plane; and for compensation, π bond is more delocalized outside the tube.
- This makes the nanotubes mechanically stronger, electrically and thermally more conductive, chemically and biologically more reactive than graphite.

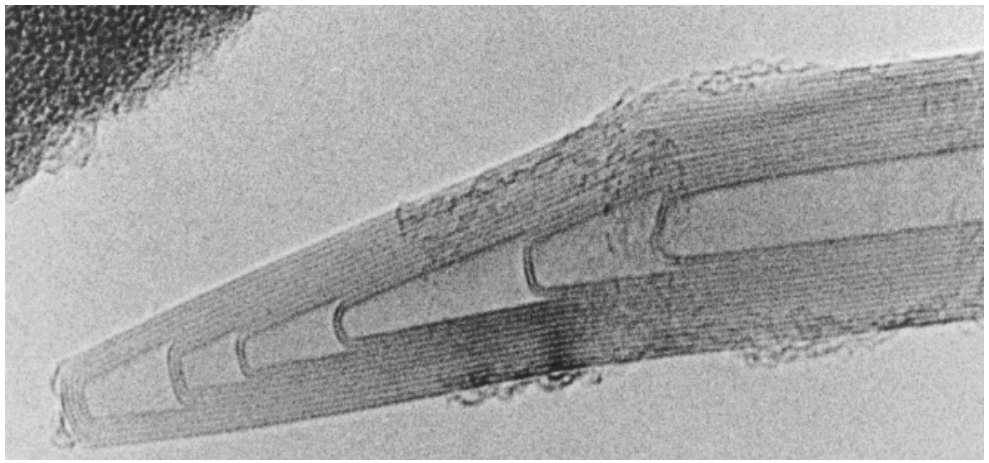
Types of Carbon NanoTubes

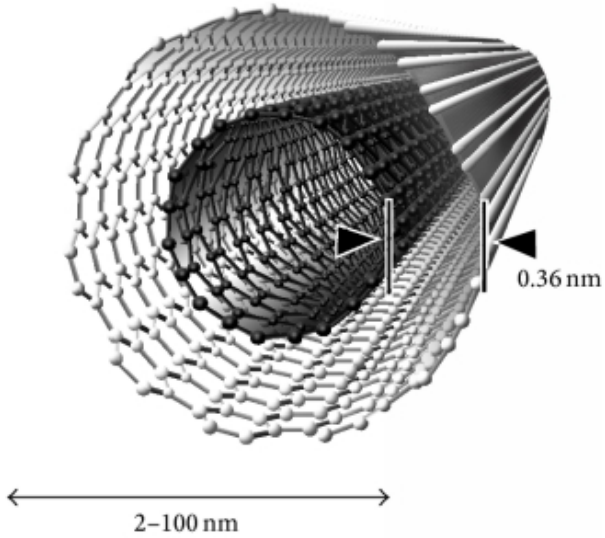
Two types of CNTs

- Single walled (SWNT): A single-atom thick graphite (graphene) sheet rolled into cylinder and capped with fullerene hemisphere.



- Multi-walled (MWNT): Multiple rolled layers (concentric tubes) of graphene.





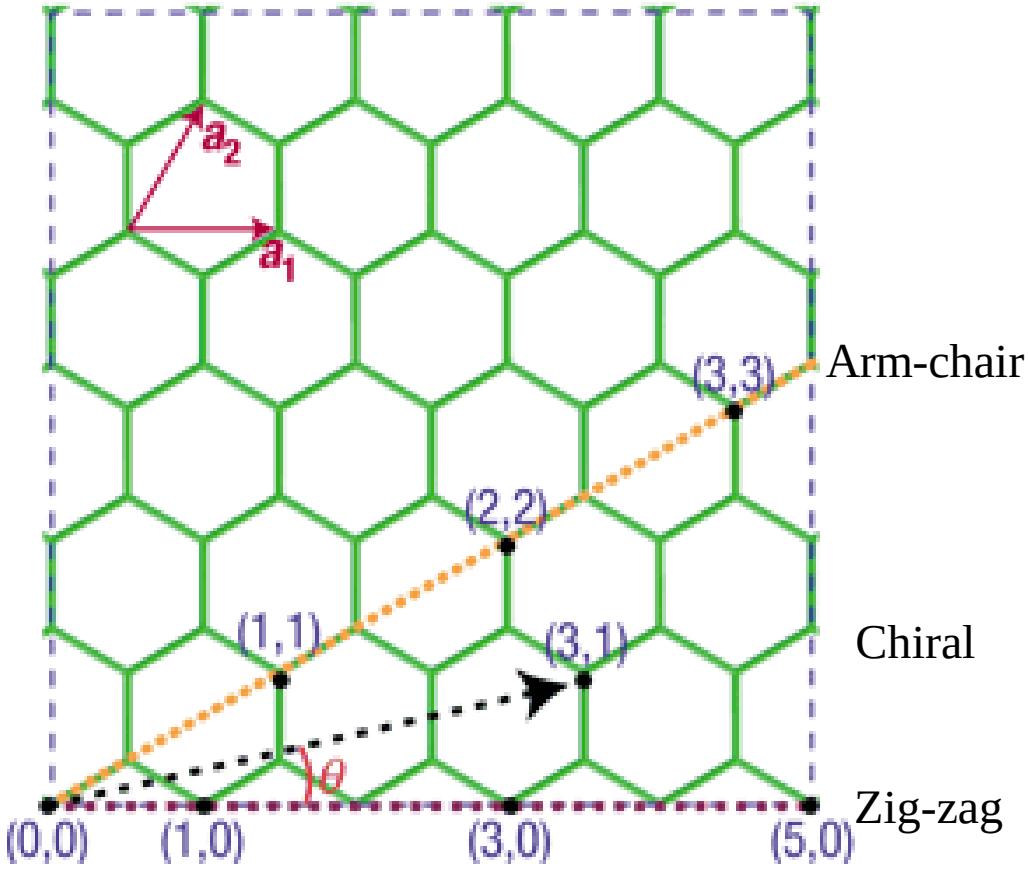
Structure of Carbon NanoTube

- SWNTs can have 3 different structures based on the direction of rolling graphene sheet.

- Nanotube lattice vectors are represented by Chiral vector

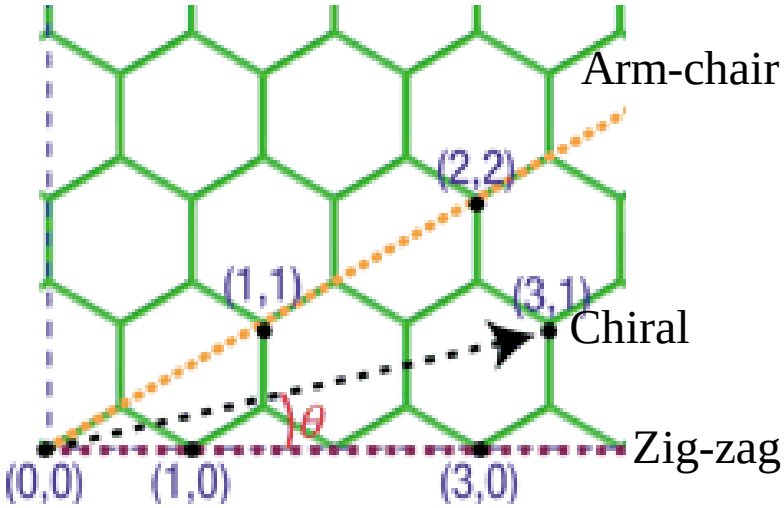
$$\vec{C}_h = n\vec{a}_1 + m\vec{a}_2$$

- a_1 and a_2 are basis vectors defined in terms of nearest-neighbour distance a_{cc} bond length of carbon atoms, a_{cc} = 0.144 nm



- Structure of nanotube depends on the chiral angle θ, defined as angle between chiral vector and zig zag direction.

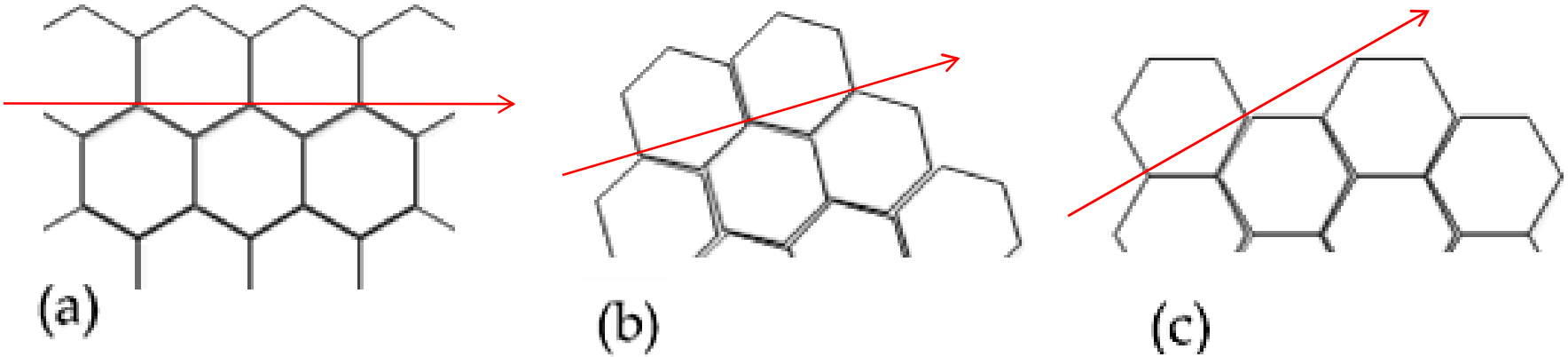
$$\theta = \tan^{-1}\left(\frac{\sqrt{3}m}{m+2n}\right)$$



(a). Zig-zag ($\theta = 0^o$ for $m = 0$)

(b). Chiral ($0 < \theta < 30^o$ for $n \neq m$)

(c). Arm chair ($\theta = 30^o$ for $n = m$)



Potential Applications