CNTS NANOSTRUCTURED MATERIALS

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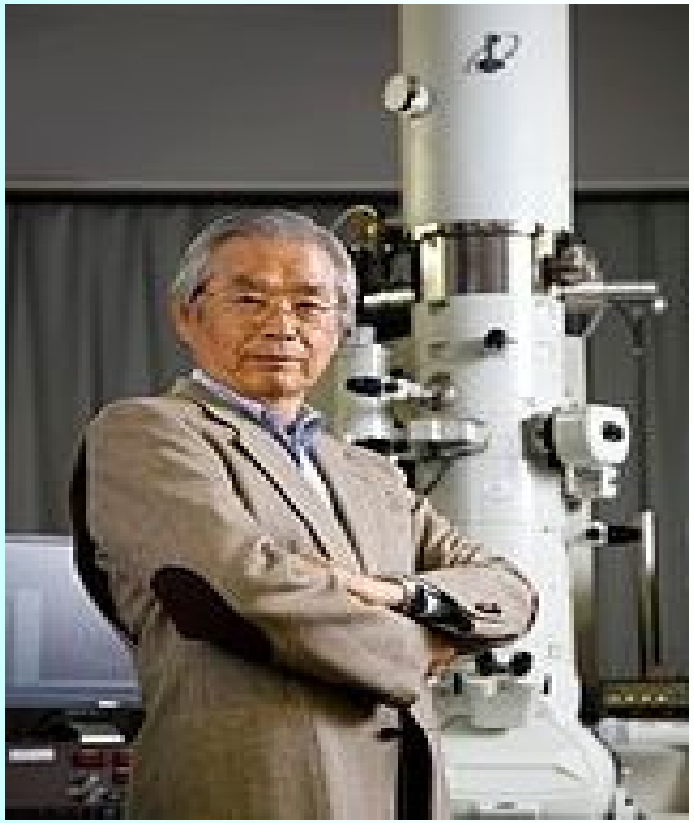
Carbon Nanotubes (CNTs)

CNTs are allotrope of carbon.

CNTs discovered in 1991 by the Japanese electron microscopist, Iijima, while studying the **arc - evaporation synthesis of fullerenes.**



TYPES OF CNTs

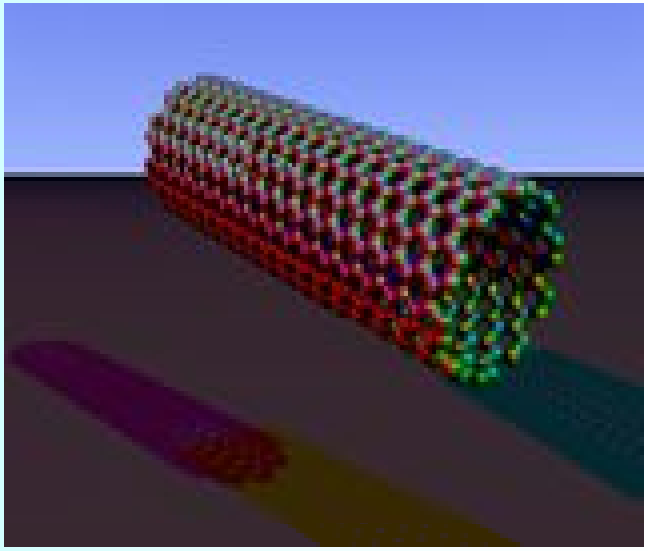
There are two types of nanotubes;

1) Single Walled Carbon Nanotubes (SWCNTs)

2) Multi Walled Carbon Nanotubes (MWCNTs)

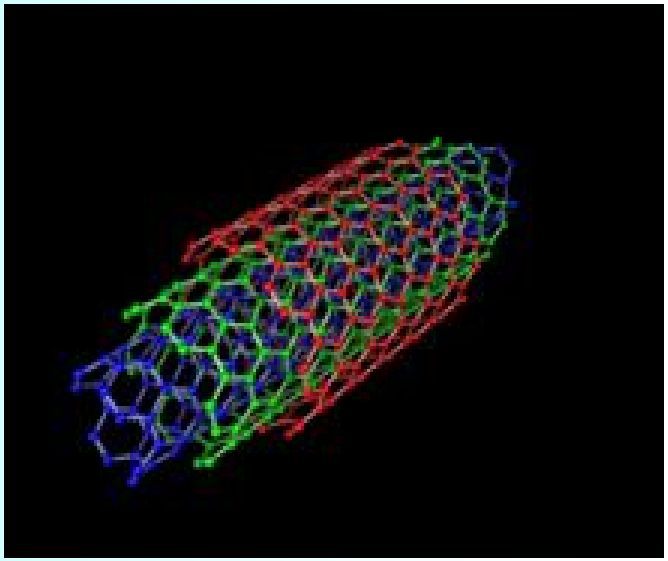
SWCNT

Here a single layer of graphene **rolled** themselves to form tube shape.



MWCNT

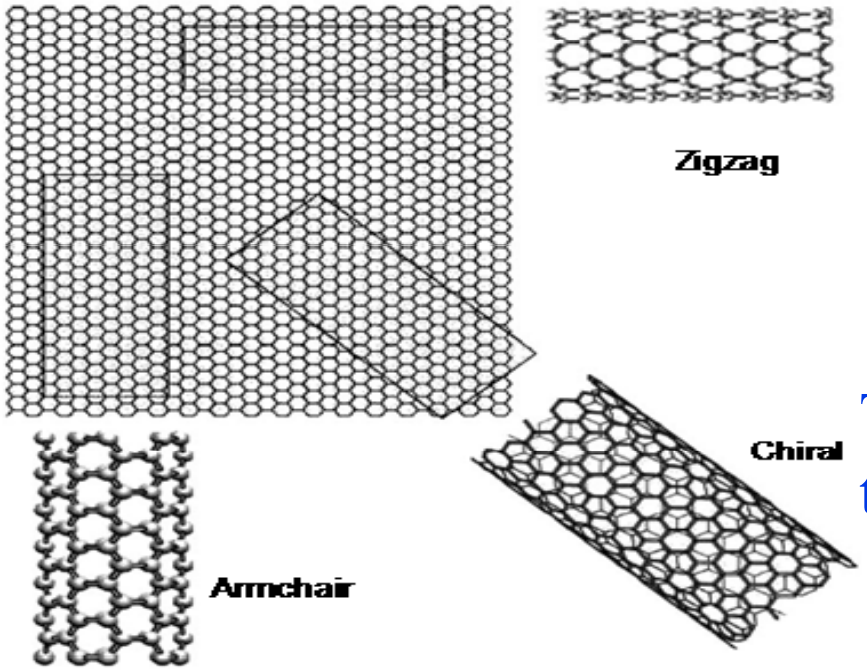
Here a multiple layers of graphene rolled themselves to form tube shape.



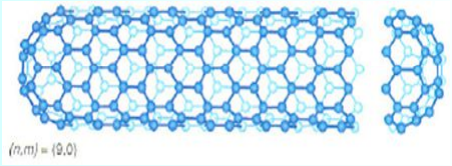
They have a diameter of few nm with a tube length of few µm.

Structures of CNTs

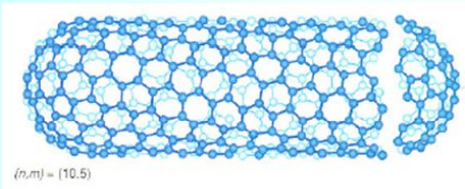
How the carbon atoms are arranged in CNTs



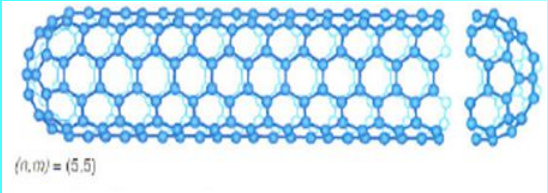
The **hexagon points** lie along the long axis of the tube.



The **configurations** lies between the two extremes.



The **hexagon flat sides** lie along the long axis of the tube.



SYNTHESIS OF CNTs

Carbon nanotubes are generally produced by the following techniques

1. Arc discharge method
2. Plasma assisted CVD method
3. Electrochemical method

Electrochemical method

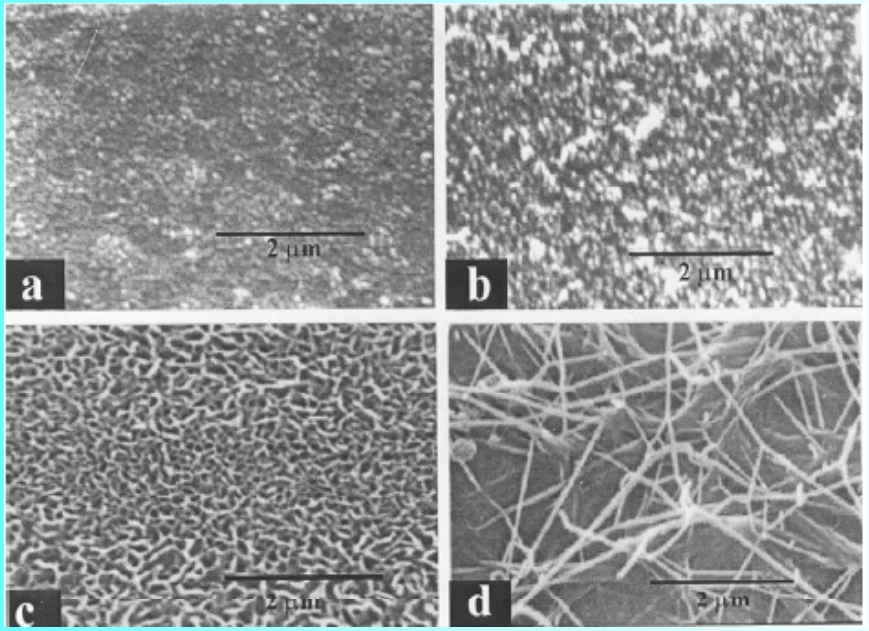
- **This method is used to synthesis CNTs at room temperature, without using any metal catalysts.**

- In this method, **1 vol. % of acetonitrile** (CH_3CN) in deionized water is used as the electrolyte.

- The deposition will take place under the voltage of **15-20 V** at room temperature.

- The growth of the CNTs on the substrate was monitored by SEM.

➢The **carbon film** obtained at intermediate times was found to be in its amorphous phase, which is subsequently converted into **CNTs at 4hr.**



SEM microstructures of the films on tin-oxide coated glass deposited for (a) t=1 h (b) t=2 h (c) t=3 h and (d) t=4 h

Mechanism

➢CH_3^+ radicals are formed from **acetonitrile** in the electrochemical process is involved to form of amorphous carbon.

$$CH_3CN + H_2O \longrightarrow CH_3^+ + CN^- + H^+ + OH^-$$

➢The **dehydrogenation of carbon** formed from CH_3^+ radicals can be predicted thro' the following reactions;

$$CH_3^+ + CH_3^+ + 2e \longrightarrow CH_2{=}CH_2 + H_2$$

$$nCH_2{=}CH_2 \longrightarrow [-CH_2CH_2-]_n$$

$$[-CH_2CH_2-]_n \longrightarrow C_n + 2nH_2$$

PURIFICATION OF CNTs

- CNTs prepared by various methods **contain impurities** such as amorphous carbon, smaller fullerenes and metal catalyst etc.

- These impurities will affect the properties of CNTs.

- Hence, purification process is required for the prepared CNTs.

PHYSICAL PROPERTIES OF CNTs

Mechanical properties

- CNTs are the **strongest and stiffest** materials due to its C-C bond strength.
- Its tensile strength is about **150 GPa**.
- It is about **30-40 times stronger** than **steel.**

Electrical properties

- CNTs can have an **electrical conductivity 1000 times higher** than **silver** and **copper.**

Thermal properties

- CNTs can have thermal conductivity **15 times higher than copper** in room temperature.
- CNTs have **thermal stability up to 2800°C** in vacuum.
- But, its **thermal stability is up to 625°C** in air.

Optical properties

- CNTs have a band gap ranging from 0.4 to 0.7 eV.
- Its band gap depends on its diameter.

CHARACTERIZATION TECHNIQUES FOR NANOSTRUCTURED MATERIALS

Studies	Information
TG/DTA	Phase formation and/or complete crystallization temperature
XRD	Phase analysis and Crystallinity
FTIR	Structural conformation
UV-Visible	Structural conformation
FE-SEM	Surface morphology and Average particle size
HR-TEM	Particle size and microstructure
DRS	Band gap determination
BET	Specific surface area
AC-Impedance	Ionic conductivity


THANK
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