Spectroscopy

التحليل الطيفي

Energy of photon

Energy of a photon

We can measure the energy of a photon using Einstein's equation:

$$E = hf = \frac{hc}{\lambda}$$

$h = 6.63 \times 10^{-34}$ Js → Planck constant

f = frequency of photon/electromagnetic radiation

$c = 3 \times 10^{8}$ m/s → speed of light in a vacuum

λ = wavelength of photon/electromagnetic radiation

Principle of IR spectroscopy

Covalent bond in molecule behave as tiny spring

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The atom will not remain in fix motion with respect to each other but the avg. distance remain same So the vibration motion is occured

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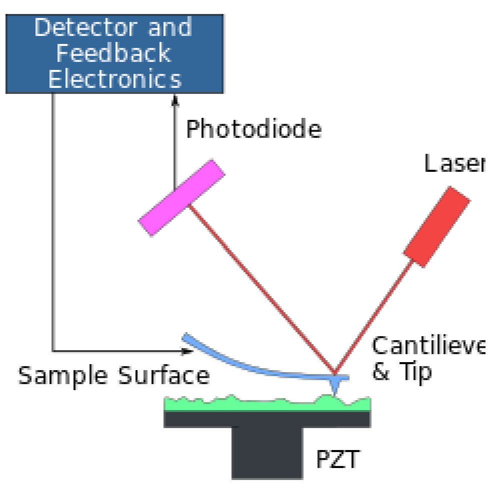
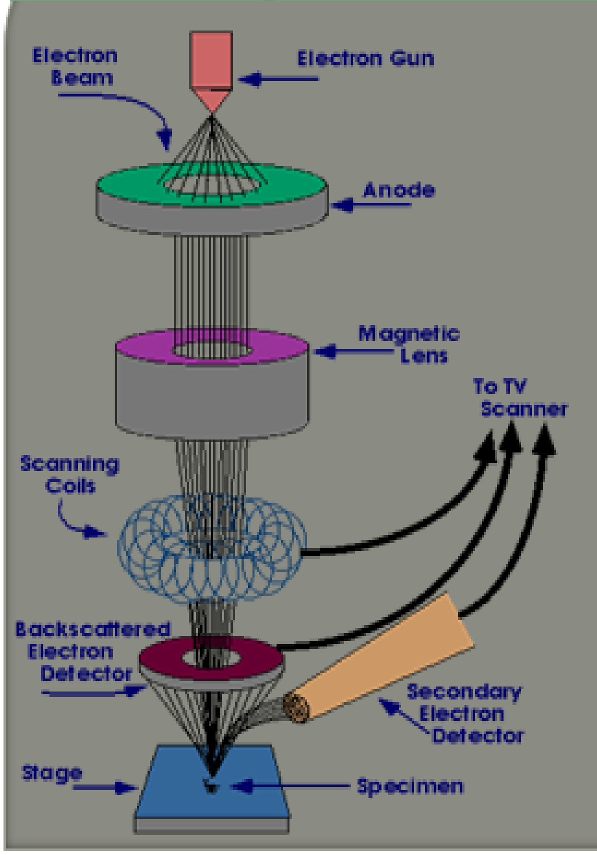
When internal vibrational energy of molecule matches with energy of externally applied IR, quantized

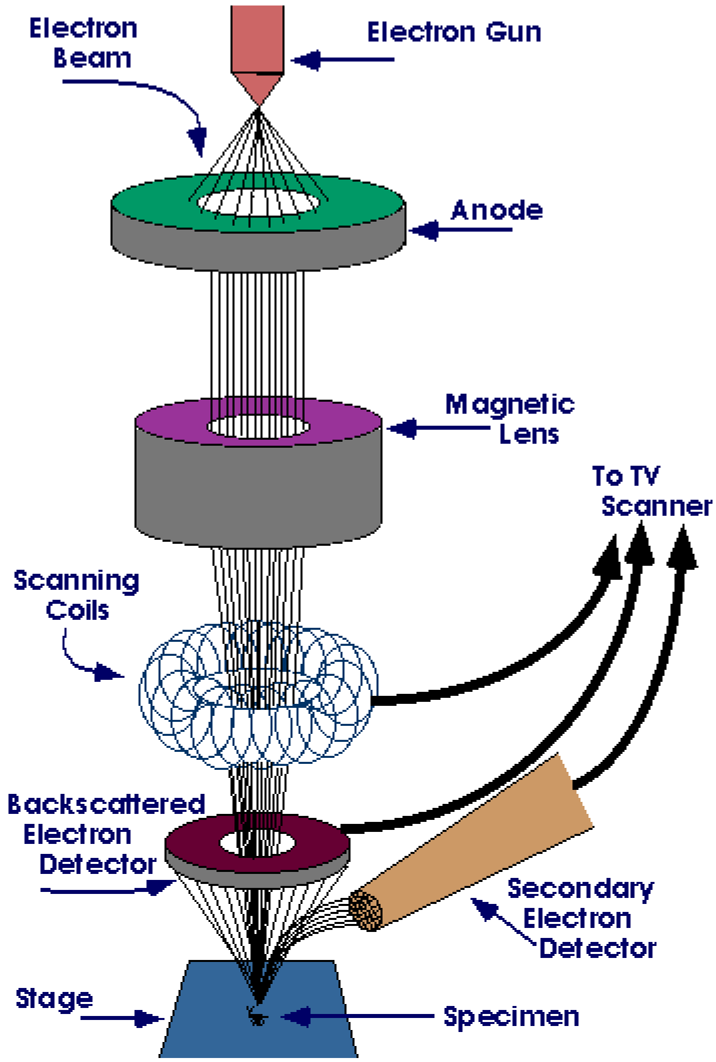


Scanning Electron Microscopy (SEM)



The SEM is an instrument that produces a largely magnified image by using electrons instead of light to form an image. A beam of electrons is produced at the top of the microscope by an electron gun. The electron beam follows a vertical path through the microscope, which is held within a vacuum. The beam travels through electromagnetic fields and lenses, which focus the beam down toward the sample. Once the beam hits the sample, electrons and X-rays are ejected from the sample.

Detectors collect these X-rays, backscattered electrons, and secondary electrons and convert them into a signal that is sent to a screen similar to a television screen. This produces the final image.



Types of Nanomaterials:-

Nanomaterials can be classified primarily into two types:

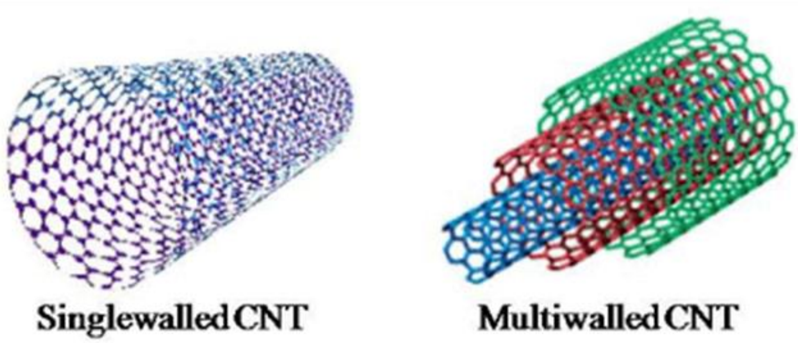
- Natural ones.(such as bond and starch)
- Artificially fabricated.

1- **Carbon Based:** These nanomaterials are composed mostly of carbon, most commonly taking the form of a hollow spheres, ellipsoids, or tubes. Spherical and ellipsoidal carbon nanomaterials are referred to as fullerenes, while cylindrical ones are called nanotubes (carbon nanotubes (CNTs)), and it can be exist as sheet called Graphene.

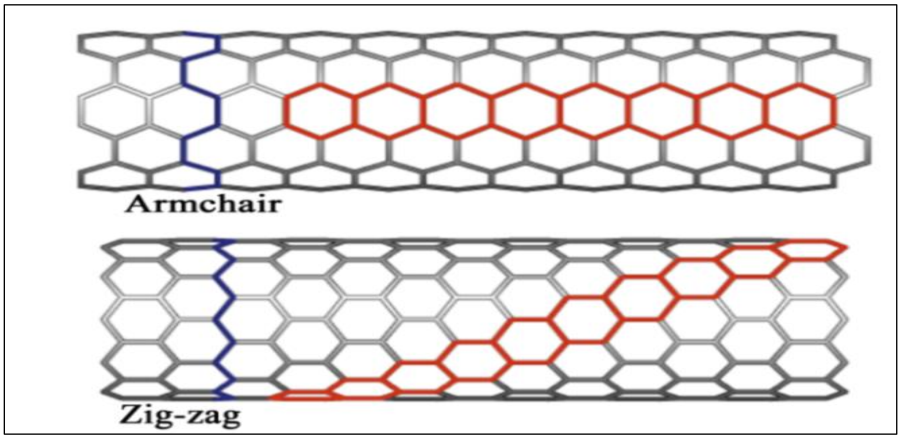
Carbon Nano Tubes (CNTs)

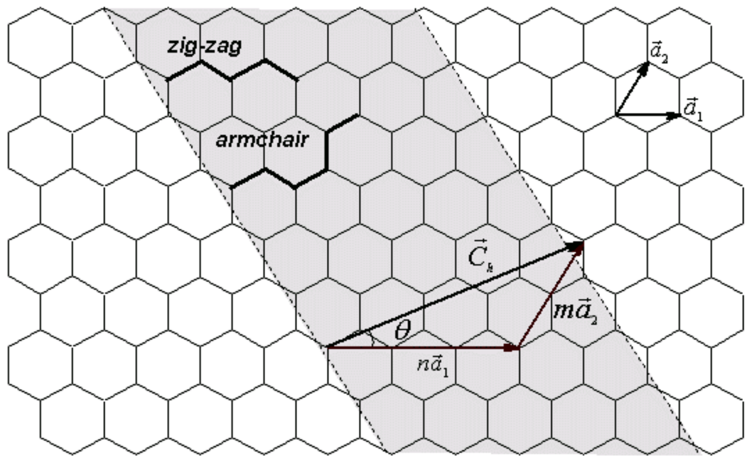
Properties of CNTs

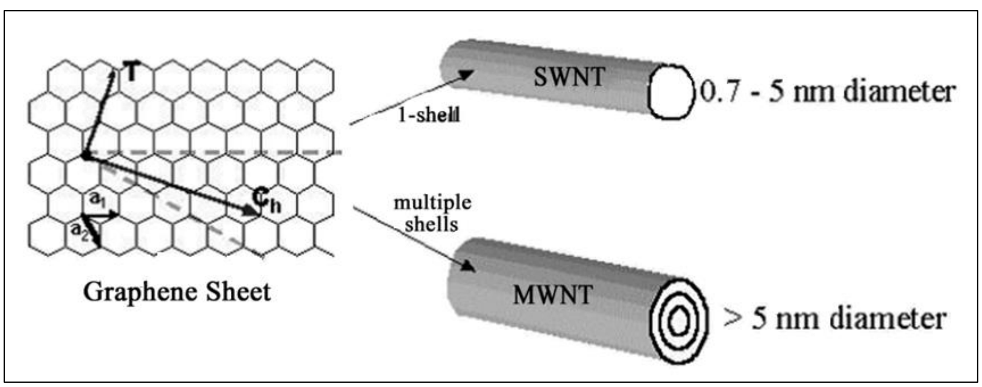
The physical appearance of CNTs is hollow cylinders of graphite carbon atoms. This tube is measured using nanoscale (10^{-9} m).



In general, the whole family of nanotubes is classified as zigzag, armchair, and chiral tubes of different diameters.

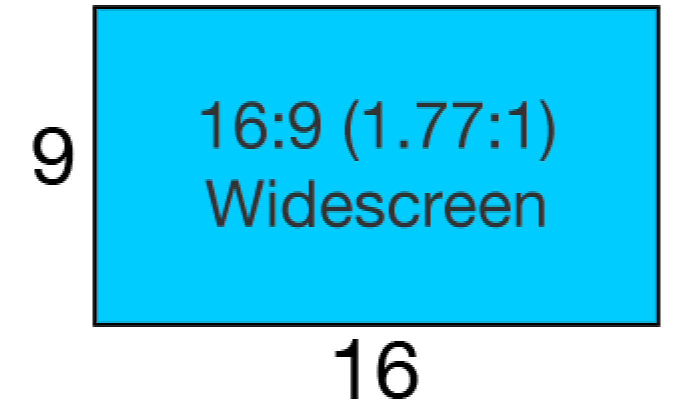






There are many advantageous and unique Properties of CNTs.

*** Aspect Ratio: aspect ratio of an image describes the proportional relationship between its width and its height.**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16:9 (1.77:1)
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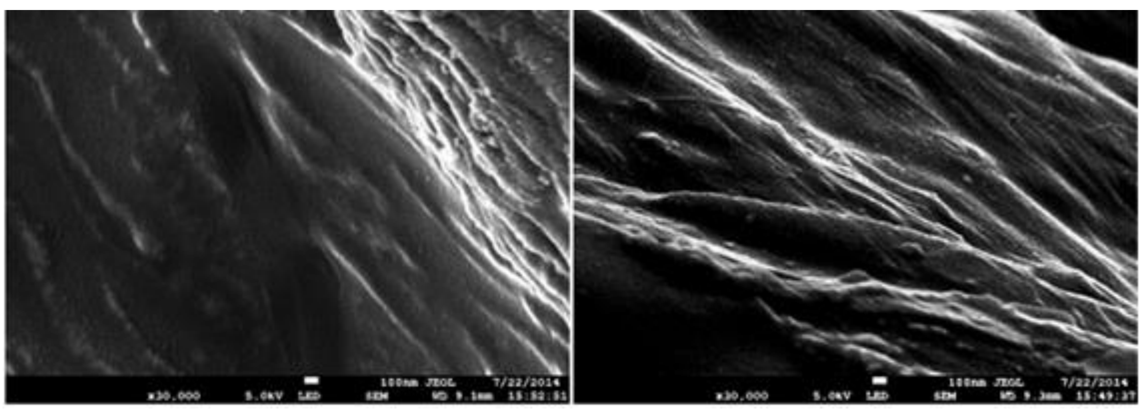
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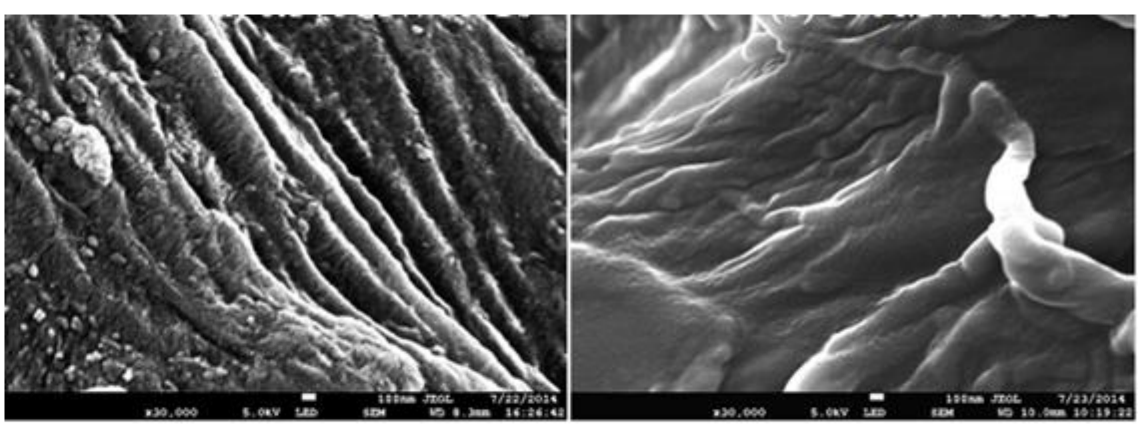
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Comparison of Mechanical Properties of CNTs with other materials.

Synthesis of CNTs: There are three main methods to Synthesis of CNTs.

(i) Arc-discharge

Arc discharge is one of the oldest and most common method for the growth of CNTs by arc-discharging graphite under an inert gas liked helium or argon. Carbon nanotubes are produced by arc vaporization at high temperature (~ 3000°C) of two carbon rods placed end to end with a distance of 1mm in an environment of inert gas such as helium, argon, at pressure between 50 to 700 mbar. Carbon rods are evaporated by a direct current of 50 to 100 amps driven by 20V which will create high temperature discharge between two electrodes

(ii) Laser Ablation

This is one of the commercially viable techniques to produce bundles of CNTs with high quality and more purity. In the laser ablation process, a pulsed laser is made to strike at graphite target in a high temperature reactor in the presence of inert gas such as helium which vaporizes a graphite target at the operating temperature of 1200°C. The nanotubes develop on the cooler surfaces of the reactor, as the vaporized carbon condenses. A water-cooled surface is also included in the most practical systems to accumulate the nanotubes.

(iii) Chemical vapor deposition (CVD)

Chemical vapor deposition is more amenable to scale-up than arc- or laser-evaporation, and many successful processes for the large-scale catalytic synthesis of both SWNTs and MWNTs have been developed. The catalysts are typically transition metal nanoparticles, such as iron, cobalt or nickel. Various hydrocarbon gases have been used, including methane, ethylene, acetylene and carbon monoxide. The growth temperature is usually (550-750) °C for MWNTs and (850-1000) °C for.

2- **Metal Based:** These nanomaterials include quantum dots, nano gold, nano silver and metal oxides, such as Oxides; Al_2O_3, MgO, ZrO_2, CeO_2, TiO_2, ZnO, Fe_2O_3 and SnO. Oxide nanoparticles can play a very important role in many areas of physical and chemical properties due to their limited size and a high density in surface sites in different fields such as optical, electronic and mechanical.

3- **Dendrimers:** These nanomaterials are nanosize polymers built from branched units like tree structure.

4- **Composites:** Composites combine nanoparticles with other nanoparticles or with larger, bulk-type materials. The composites may be any combination of metal based, carbon based or polymer based nanomaterials with any form of metal, ceramic, or polymer bulk materials.