19CH101– ENGINEERING CHEMISTRY

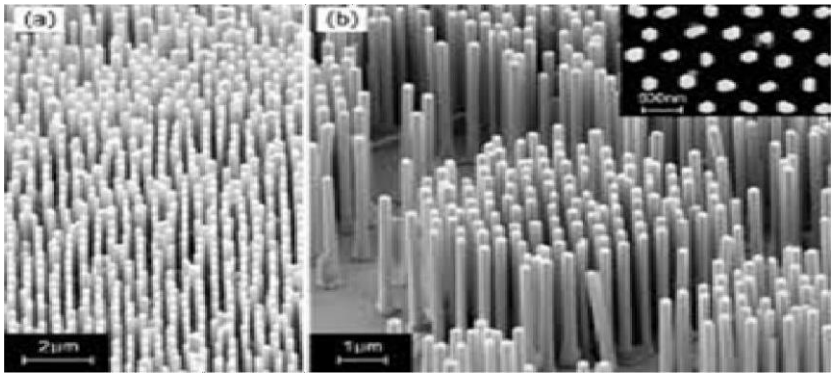
Unit-3 NANOCHEMISTRY

NANORODS

Nanostructures shaped like long sticks or dowels with a diameter in the nanoscale but having a length that is very much longer.

Description

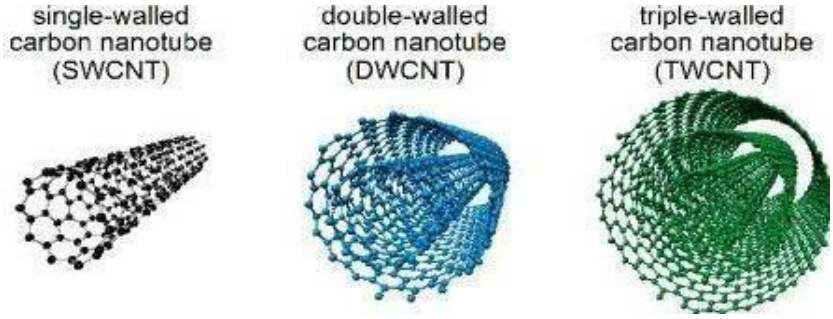
a) In nanotechnology, nanorods are one morphology of nanoscale objects.
Each of their dimensions range from 1–100nm. They may be synthesized from metals or semiconducting materials. Standard aspect ratios (length divided by width) are 3-5.
b) Nanorods are produced by direct chemical synthesis. A combination of {ligands} act as shape control agents and bond to different facets of the nanorod with different strengths. This allows different faces of the nanorod to grow at different rates producing an elongated object.



Applications

The applications of nanorods are diverse, ranging from display technologies (the reflectivity of the rods can be changed by changing their orientation with an applied electric field) to microelectromechanical systems (MEMS), optical, sensing, solar cells, magnetic, and electronic device applications.

NANO TUBES



Carbon nanotubes are allotropes of carbon with a nanostructure having a length- do-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' held together by Vander waals forces. Each carbon atoms in the carbon nanotubes are linked by the covalent bond (sp^2 bond)

Structure (or) Types of carbon nanotubes

Carbon nanotubes are lattice of carbon atoms, in which each carbon is covalently bonded to three other carbonatoms.

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

(i) Single-walled nanotubes (SWNTs)
(ii) Multi-walled nanotubes (MWNTs)

Synthesis of carbon nanotubes

Carbon nanotubes can be synthesized by any one of the following methods.

(i) Pyrolysis of hydrocarbons
(ii) Laser evaporation
(iii) Carbon arc method
(iv) Chemical vapour deposition

(i) Pyrolysis

Carbon nanotubes are synthesized by the pyrolysis of hydrocarbons such as acetylene at about $700^{O}C$ in the presence of Fe-Silica or Fe-graphite catalyst under inert conditions.

(ii) Laser evaporation

It involves vapourization of graphite target, containing, small amount of cobalt and nickel, by exposing it to an intense pulsed laser beam at higher temperature ($1200^{O}C$) in a quartz tube reactor. An inert gas such as argon is simultaneously allowed to pass into the reactor to sweep the evaporated carbon atoms from the furnace to the colder copper collector, on which they condense as carbon nanotube.

(iii) Carbon arc method

It is carried out by applying direct current (60 – 100 A and 20 – 25 V) arc between graphite electrodes of 10 – 20 m diameter.

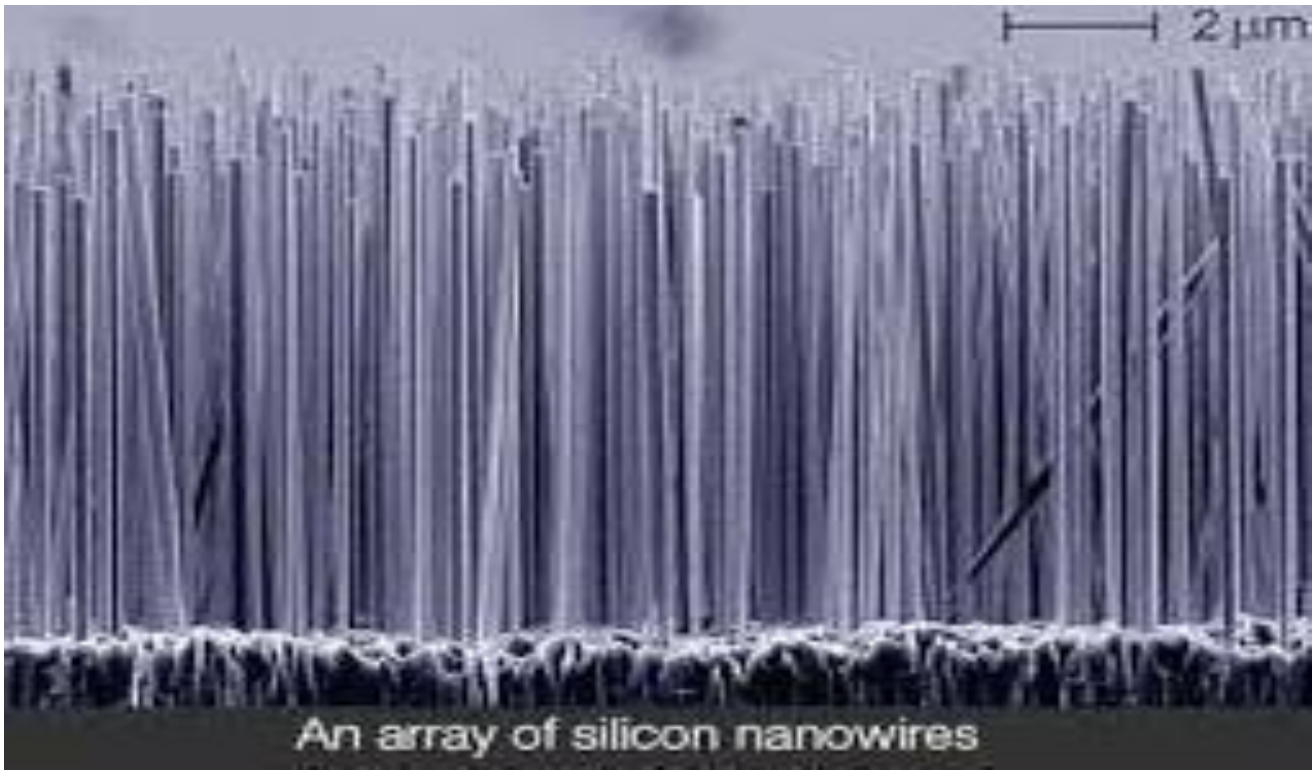
(iv) Chemical vapour deposition

It involves decomposition of vapour of hydrocarbons such as methane, acetylene, ethylenes, etc. at high temperatures ($1100^{O}C$) in presence of metal nanoparticle catalyst like nickel, cobalt, iron supported on MgO or Al_2O_3.
Carbon atoms produced by the decomposition condense on a cooler surface of the
catalyst.

NANOWIRE

A nanowire is a nanostructure, with the diameter of the order of a nanometer (10^{-9} meters). Alternatively, it can be defined as structures that have a thickness or diameter constrained to tens of nanometers or less and an unconstrained length.

At these scales, quantum mechanical effects are important — which coined the term "quantum wires". Many different types of nanowires exist, including metallic (*e.g.*, Ni, Pt, Au), semiconducting (*e.g.*, Si, InP, GaN, etc.), and insulating (*e.g.*, SiO_2, TiO_2).



An array of silicon nanowires

Characteristics of Nanowires

- Silicon nanowires exhibit strong photoluminescencecharacteristics.
- Nanowires are dimensional material.
- It shows distinct optical, chemical, thermal and electrical properties due to this large surface area.