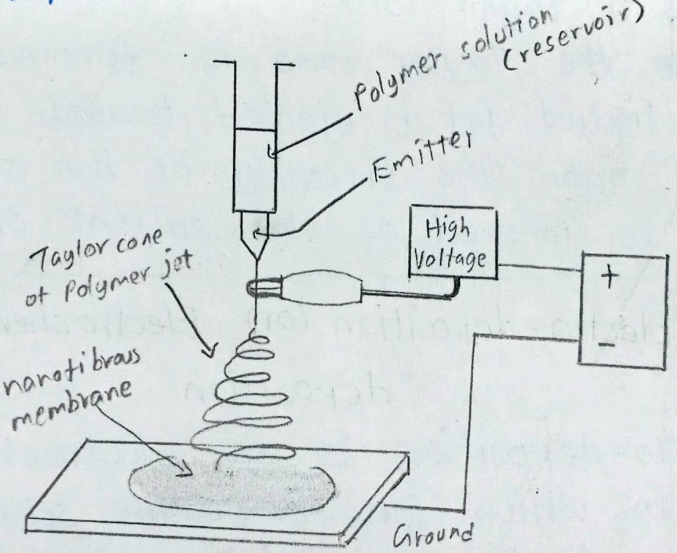
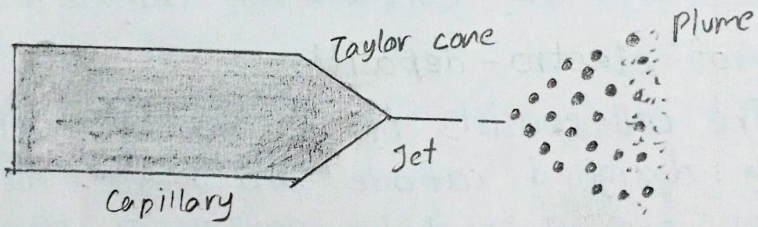
Electrospinning

Electrospinning is a method of producing ultrafine (in nanometers) fibres by charging and ejecting a polymer solution through a spinneret under a high-voltage electric field and to solidify (or) coagulate it to form a filament.





Components

1. A high voltage Power supply
2. A polymer reservoir that can maintain a constant flow rate of solution.
3. A conductive needle, as polymer source, connected to the high voltage power supply.
4. A conductive collector (plate, drum, etc.)

Process

A polymer is dissolved in a suitable solvent and

is filled in the capillary reservoir. When sufficiently high voltage is applied to create an electric field between the needle tip and the collector, a charge accumulates at the liquid surface. When the electrostatic repulsion is higher than the surface tension the liquid meniscus is deformed into conically shaped structure known as a Taylor cone.

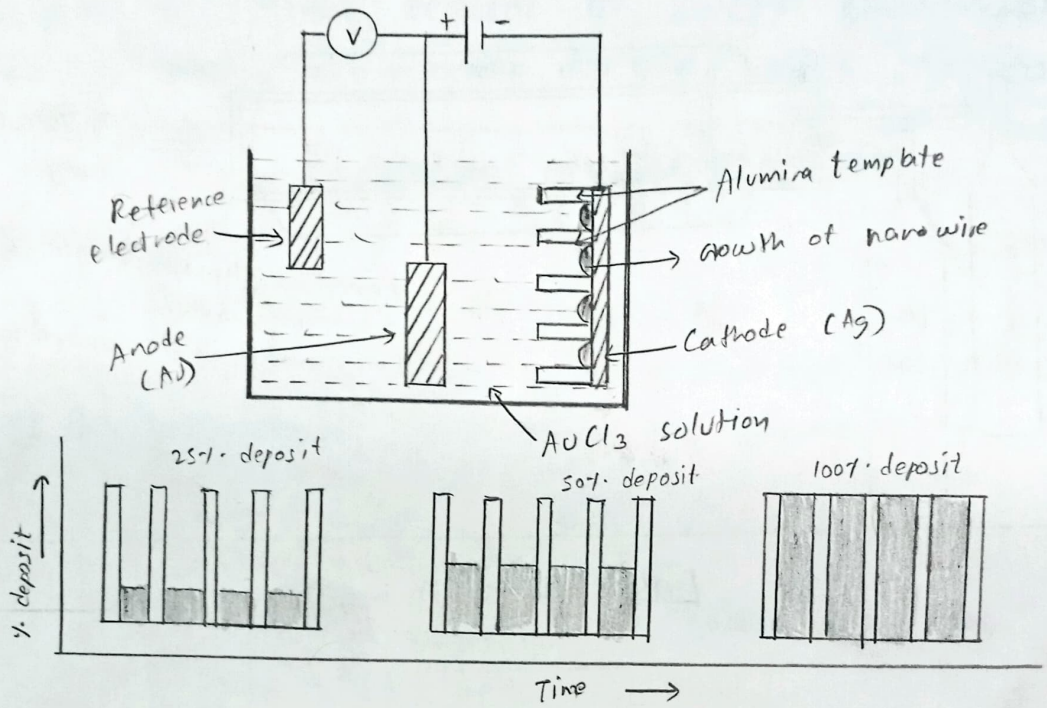
Once the Taylor cone is formed, the charged liquid jet is ejected towards the collector. Depending upon the viscosity of the solution, solid fibre will be formed as the solvent evaporates.

Electro-deposition (or) Electrochemical deposition

Electro-deposition is an electrochemical method in which ions from the solution are deposited at the surface of cathode.

Process of electro-deposition

The cell consists of a reference electrode, specially designed cathode and anode. All these electrodes are connected with the battery through an voltmeter and dipped in an electrolytic solution of a soluble metal as shown in figure. When the current is passed through the electrodes of template, the metal ions from the solution enter into the pores and gets reduced at the cathode, resulting in the growth of nanowire inside the pores of the template.

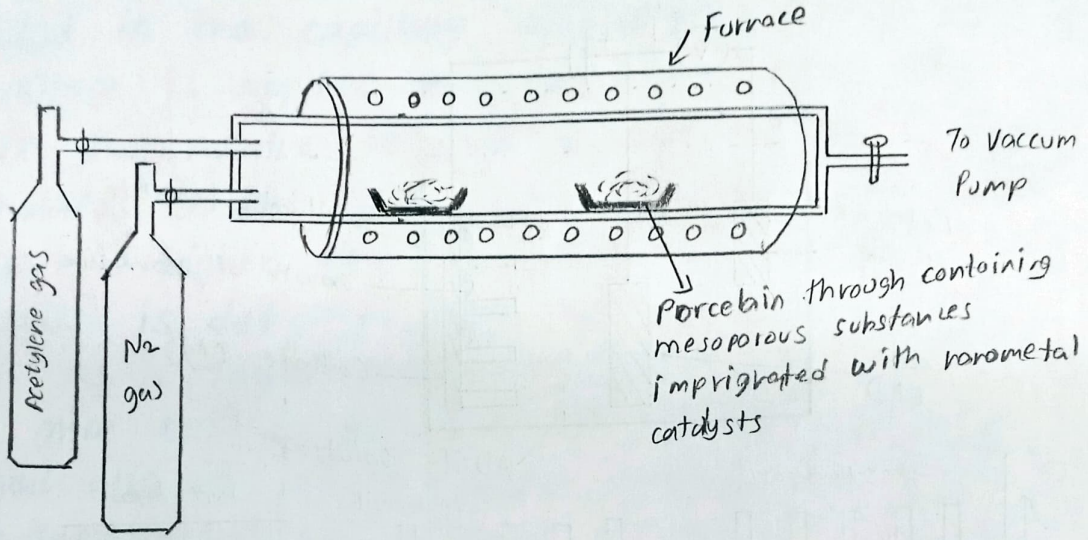


Chemical Vapour deposition

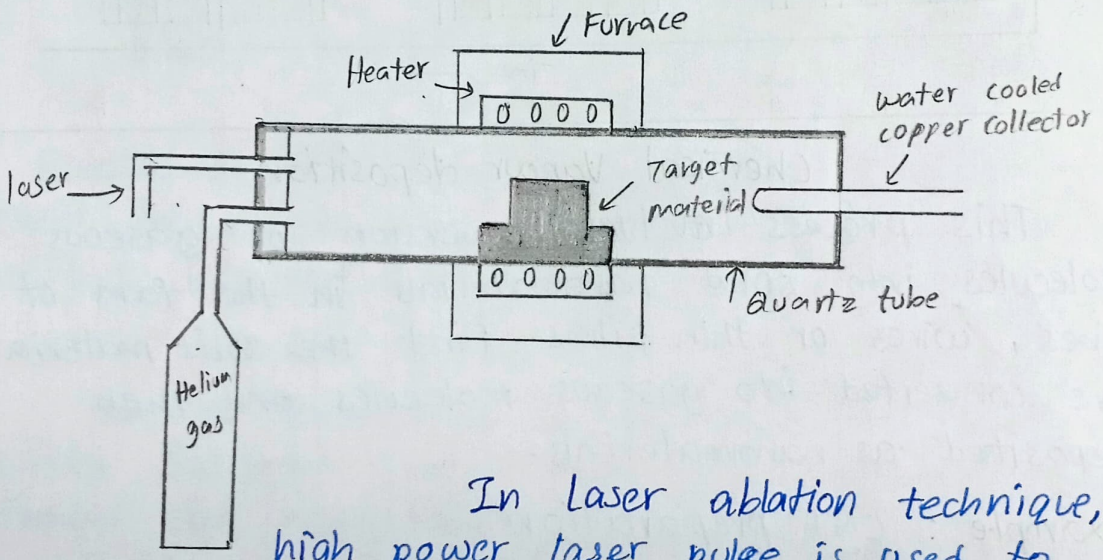
This process involves conversion of gaseous molecules into solid nanomaterials in the form of tubes, wires or thin films. First the solid materials are converted into gaseous molecules and then deposited as nanomaterials.

Example : CNT preparation

The CVD reactor consists of a higher temperature vaccum furnace maintained at inert atmosphere. The solid substrate containing catalyst like nickel, cobalt, iron supported on a substrate material like, silica, quartz is kept inside the furnace. The hydrocarbons such as ethylene, acetylene and nitrogen cylinders are connected to the furnace. Carbon atoms, produced by the decomposition at 1000°C, condense on the cooler surface of the catalyst.



Laser ablation



In Laser ablation technique, high power laser pulse is used to evaporate the material from the target. The stoichiometry of the material is protected in the interaction. The total mass ablated from the target per laser pulse is referred to as the ablation rate. This method involves vapourisation of target material containing small amount of catalyst (nickel or cobalt) by passing a intense pulsed laser beam at a higher temperature to about 120°c in a quartz tube reactor. Simultaneously, an inert gas such as argon, helium is allowed

to pass into the reactor to sweep the evaporated particles from the furnace to the colder collector.

Applications of Nanomaterials

- In Energy

a) Reducing the cost of solar cell

Nanotech solar cells are manufactured at significantly lower cost than the conventional solar cells.

b) Nano battery and fuel cell

Nanomaterials, used in batteries and fuel cell, increases their efficiency.

c) Generating electricity from waste heat

Sheets of nanotubes have been used to build thermo cells that generates electricity, when the sides of the cell are at different temperature.

- Electronics

a) Nano wires are used to build transistors without p-n junctions.

b) MOSFET (Metal Oxide Semi Conductor Field Effect Transistor), performs both as switches and as amplifiers.

c) Quantum wires are found to have high electrical conductivity.

- Medicine

a) Nano drugs

Nano materials are used as nano drugs for the cancer and TB therapy.

b) Nano-medibots

Nano particles function as nano-medibots that release anti-cancer drug and treat cancer.

c) Laboratories on a chip.

Nano technology is used in the production of laboratories on a chip

- In Agriculture

a) They also minimize the amount of harmful chemicals that pollute the environment.

b) Nanosensors are used in crop protection for the identification of diseases and residues of agrochemicals.

c) Nano devices are used for the genetic engineering of plants.

- In Catalysis

1. Water purification

Nanosilver catalyst is highly efficient in controlling microbes in water.

2. fuel cell application

Carbon supported electro-catalysts play an important role in fuel cell.

3. Bio-diesel production

Solid base nano catalyst KF/CaO can be used for biodiesel production with yield more than 96%.

~ Thank you