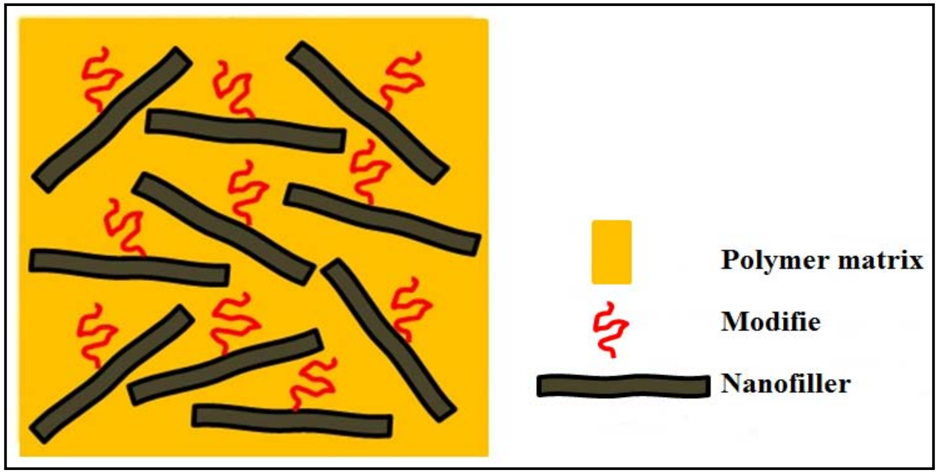
Lecture 8

Polymer nanocomposites

Polymer nanocomposites

"Polymer nanocomposites are one of the important modern technologies for industrial applications due to its capability of producing better physical and chemical properties after the addition of low weight percentages of nano-fillers in the polymer matrices.

The majority of polymer nanocomposite systems include the three main components which are the polymer matrix, nano-sized particles (or nanofillers) and organic modifier.

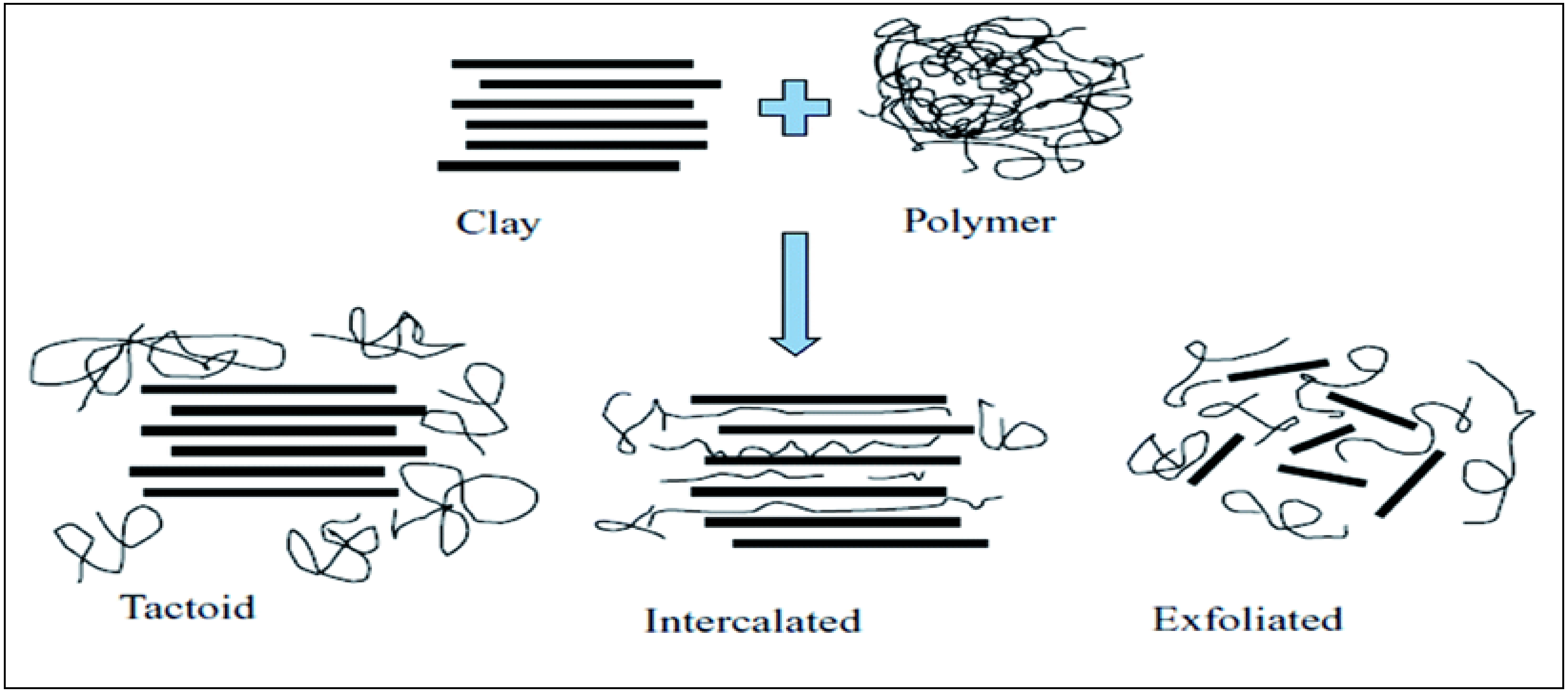


Advantages of Nanofluids

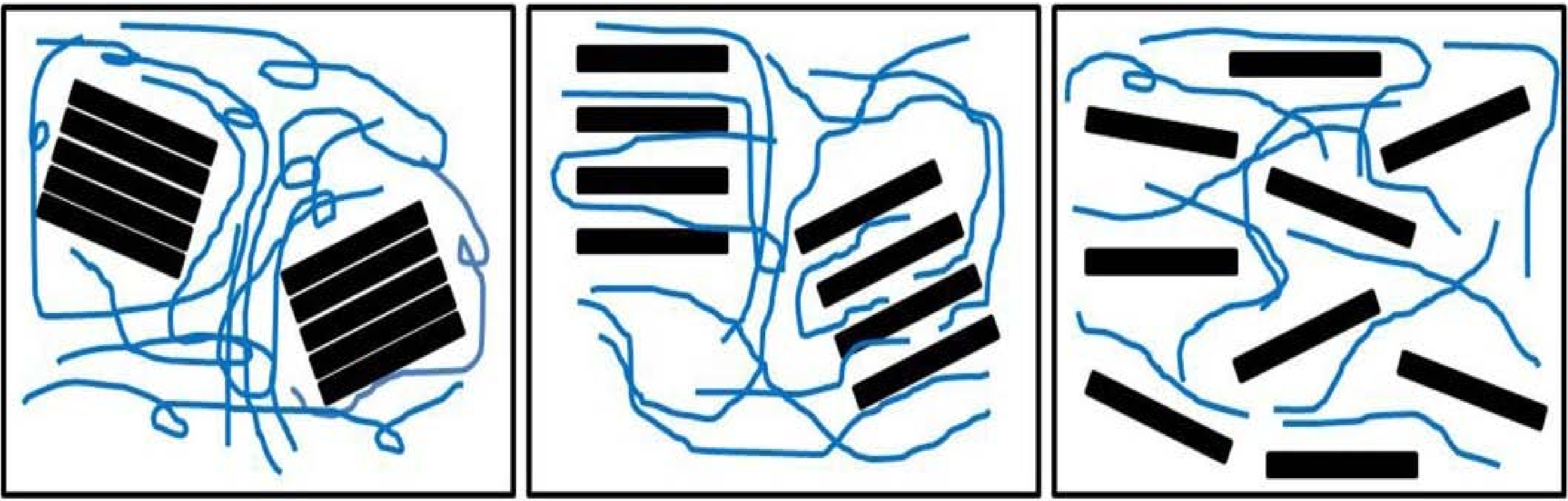
The advantage of polymer nanocomposite offer the potential for enhanced mechanical properties, barrier properties, thermal properties and flame retardant properties when compared to conventionally composite. Therefore, nanocomposites promise new applications in many fields such as mechanically-reinforced lightweight components, non-linear optics, battery cathodes and Ionics, nanowires, sensors and numerous other systems. Due to the higher surface area available with nanofillers, polymer nanocomposites.

STRUCTURE OF POLYMER NANOCOMPOSITES

The three steps required in this process is the initial surface wetting of filler tactoids by polymer molecules, after which there is an intercalation or infiltration of polymer into nanofiller galleries, and finally the exfoliation of nano-fillers into the polymer matrix.



Structure of polymer nanocomposite



a

Separated

b

Intercalated

c

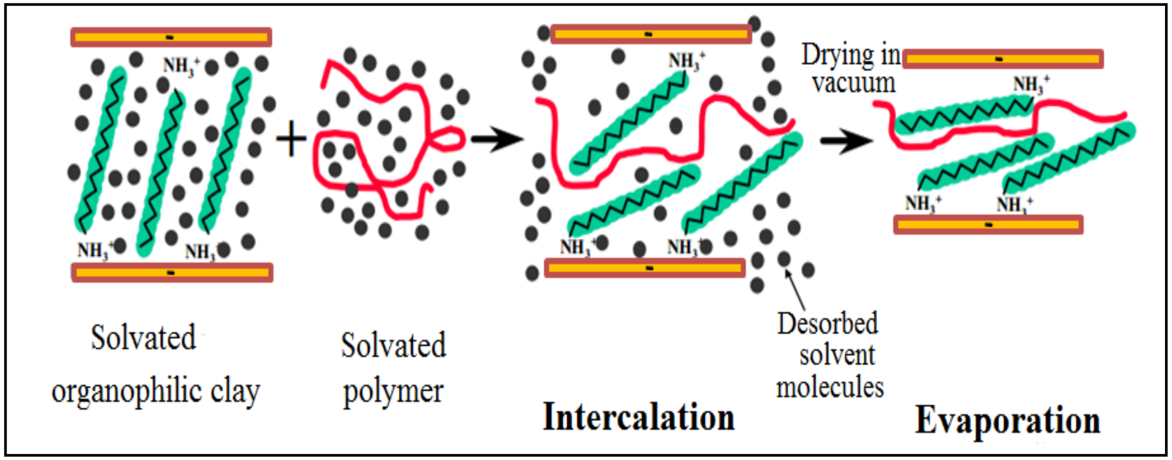
Exfoliated

PREPARATION METHODS OF POLYMER NANOCOMPOSITES

In general, there are three preparation methods widely used to synthesize polymer nanocomposites:

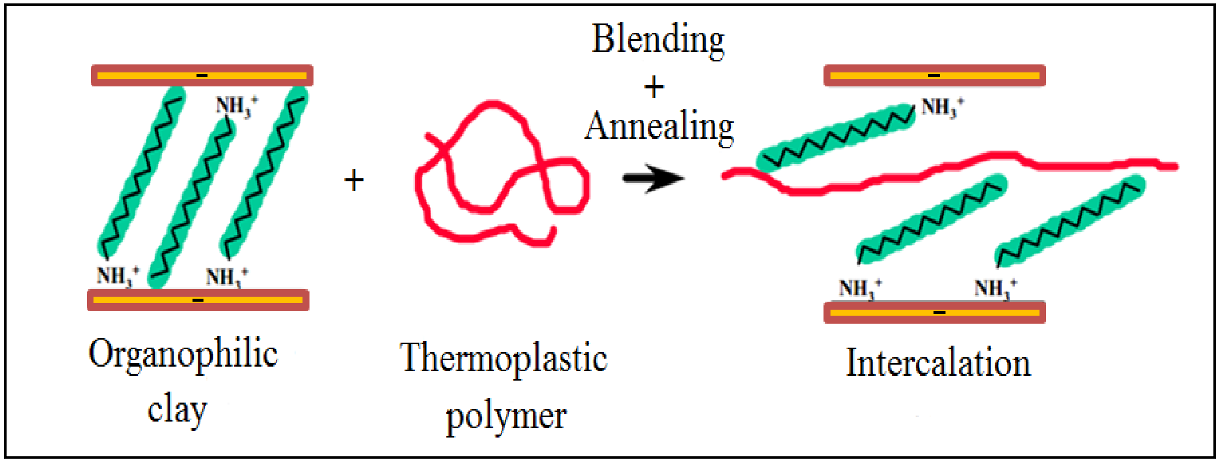
1-Solution Intercalation:

A solvent is employed in solution intercalation, resulting in the simultaneous dispersion of nano layers and dissolvent of organic polymer matrix in the same solvent.



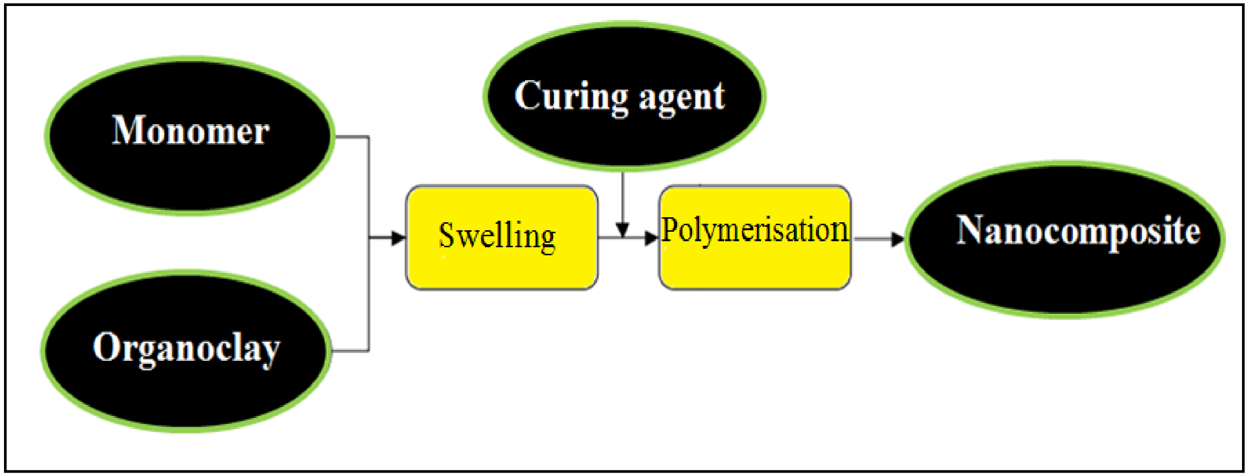
2- Melt Intercalation:

The melt intercalation technique is considered in nanocomposite synthesis. To achieve well dispersion, sheer force mixing and high temperatures are employed to disperse fillers into a polymer matrix.



3- In Situ Polymerization:

The in-situ polymerization technique is widely applied due to a number of advantages, such as ease of handling and high performance for the final products' properties. This method is often favoured due to more control on the nanocomposite dispersion obtained.



Synthesis of CNTs

***There are three main methods synthesis to 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.

Synthesis of CNTs

- **(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.