

PG Semister II

Core Course - V

UNIT-II . Chemistry of Nanomaterials

- The branch of science and technology deals with materials having at least one spatial dimension in the size range of 1 to 100 nm.
- The term nano originated from the Greek name which means 'dwarf'. It is one billionth of a meter.
- The concept of nanotechnology was first given by renowned physicist Richard Feynman in 1959 and earned Nobel Prize.
- The term was also popularised by the invention of scanning tunneling microscope and fullerene.
- Richard P. Feynman, delivered a famous lecture entitled "There's Plenty of Room at the Bottom" in the annual meeting of the American Physical Society at California Institute of Technology on 26 December 1959. In this lecture, he talked about writing twenty four volumes of the Encyclopedia Britannica on the head of a pin, and miniaturizing the computer.
- The lecture of Feynman had inspired many scientists in various ways. For example K. Eric Drexler wrote a book (in 1986) entitled "Engines of Creations: The coming Era of Nanotechnology".

iii) Two dimensional nanomaterials

Here, one dimension (x) is at nanoscale and the other two are outside the nanoscale. The 2D nanomaterials exhibit plate like shapes. It includes nanofilms, nanolayers and nanocoatings with nanometer thickness.

iv) Three dimensional nanomaterials

These are the nanomaterials that are not confined to the nanoscale in any dimension. These materials have three arbitrary dimensions above 100 nm. The bulk (3D) nanomaterials are composed of a multiple arrangement of nanosize crystals in different orientations. It includes dispersions of nanoparticles, bundles of nanowires and nanotubes as well as multilayers (polycrystals) in which the 0D, 1D and 2D structural elements are in close contact with each other and form interface.

For better understanding, nanomaterials are again organised into four types.

- i) Carbon based materials.
- ii) Metal based materials.
- iii) Dendrimers
- iv) Composites.

i) Carbon based materials

These are composed of carbon, taking the form of hollow spheres, ellipsoids or tubes. The spherical and ellipsoidal forms are referred as fullerenes, while cylindrical forms are called nanotubes.

ii) Metal based materials

These include quantum dots, nanogold, nanosilver and metal oxides like TiO_2 . A quantum dot is a closely packed semiconductor crystal comprised of hundreds or thousands of atoms, whose size is on the order of a few nanometers to a few hundred nanometers.

iii) Dendrimers

Dendrimers are repetitively branched molecules. The name comes from the Greek word 'dendron' (tree). These nanomaterials are nanosized polymers built from branched units. The surface of a dendrimer has numerous chain ends, which can perform specific chemical functions. Dendrimers are used in molecular recognition, nanosensing, light harvesting and opto-electrochemical devices. They may be useful for drug delivery.

iv) Composites - Composites are combination of nanoparticle with other nanoparticles or with larger, bulk type-material. Nanoparticles like nanosized clays are added to products (auto parts, packaging materials etc) to enhance mechanical, thermal and flame-retardant properties.