



19CH101– ENGINEERING CHEMISTRY

Unit-3 NANOCHEMISTRY

INTRODUCTION

Nanochemistry is a branch of nanoscience, deals with the chemical applications of nanomaterials in nanotechnology. Nanochemistry involves the study of the synthesis and characterization of materials of nanoscale size.

Nanochemistry is a relatively new branch of chemistry concerned with the unique properties associated with assemblies of atoms or molecules of nanoscale (~1-100 nm), so the size of nanoparticles lies somewhere between individual atoms or molecules (the 'building blocks') and larger assemblies of bulk material which we are more familiar with.

There are physical and chemical techniques in manipulating atoms to form molecules and nanoscale assemblies.

Physical techniques allow atoms to be manipulated and positioned to specific requirements for a prescribed use.

Traditional chemical techniques arrange atoms in molecules using well characterized chemical reactions.

Nanochemistry is the science of tools, technologies, and methodologies for novel chemical synthesis e.g. employing synthetic chemistry to make nanoscale buildingblocks of desired (prescribed) shape, size, composition and surface structure and possibly the potential to control the actual self-assembly of these building blocks to various desirable size.



DEFINITIONS

(i) Nanoparticles

Nanoparticles are the particles, the size of which ranges from 1 to 50 nm. Generally they are obtained as colloids. The colloidal particles have a tendency to remain single crystal and hence are called as nanocrystals. A large percentage of atoms in nanocrystals are present on the surface.

Nanocrystals possess electronic, magnetic and optical properties. Since the nanoparticles exhibit an electronic behavior, governed by the quantum physics, they are also called as quantum dots.

(ii) Nanomaterials

- Nanomaterials are the materials having components with size less than 100 nm at least in one dimension.
- Nanomaterials, in one dimension, are layers such as a thin film or surface coatings.
- Nanomaterials, in two dimension, are tubes such as nanotubes and nanowires.
- Nanomaterials, in three dimensions, are particles like precipitates, colloids and quantum dots.

Properties (or) Characteristics of nanomaterials

- (i) Nanomaterials possess very good electrical properties and thermal conductivity.
- (i) It possesses very strong and withstands extreme strain and tension.



(iii) Nanochemistry (or) Nanoscience

Nanoscience is defined as the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales.

(iv) Nanotechnology

Nanotechnology, is defined as the design, characterization, production and applications of structures, systems and devices by controlling size and shape at 10^{-9} m scale or the single atomic level.

DISTINCTION BETWEEN MOLECULES, NANOPARTICLES AND BULK MATERIALS

(a) Molecules:

- Molecules is a collection of atoms. The size of the molecules are in the range of picometers.
- Molecule is the smallest particle in a chemical element or compound that has the chemical properties of that element or compound.
- Molecules are made up of atoms that are held together by chemical bonds.

(b) Nanoparticles:

- Nanoparticles are collection of few molecule that is less than 100 nm
- Nanoparticles are less than 100 nanometers diameter.
- Nanoparticles size is so small that their physical properties are not constant over their size. They tend to have unique size-dependent properties that can be described using quantum physics.
- Surface area of nanoparticles is more.

(c) Bulk materials:

- Bulk materials are collection of thousands of molecules.
- Bulk particles are larger, in the micron size range or bigger.