19CH101– ENGINEERING CHEMISTRY

Unit-3 NANOCHEMISTRY

TYPES OF NANOMATERIALS

Nanoparticles can be classified into different types according to the size, morphology, physical and chemical properties. Some of them are

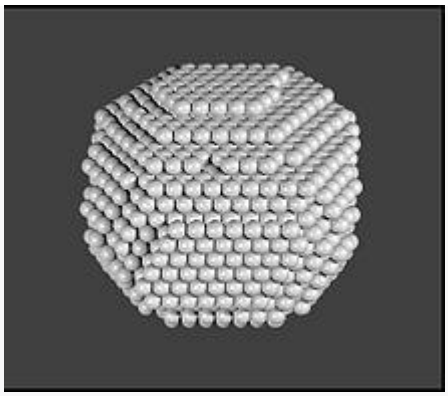
- carbon-based nanoparticles
- ceramic nanoparticles
- metal nanoparticles
- semiconductor nanoparticles
- polymeric nanoparticles
- lipid-based nanoparticles.

NANO PARTICLES

A nanoparticle or ultrafine particle is usually defined as a particle of matter that is between 1 and 100 nanometres (nm) in diameter.The term is sometimes used for larger particles, up to 500 nm, or fibers and tubes that are less than 100 nm in only two directions. At the lowest range, metal particles smaller than 1 nm are usually called atom clusters instead.

Nanoparticles are usually distinguished from microparticles (1-1000 μm), "fine particles" (sized between 100 and 2500 nm), and "coarse particles" (ranging from 2500 to 10,000 nm), because their smaller size drives very different physical or chemical properties, like colloidal properties and ultrafast optical effects or electric properties.

The properties of nanoparticles often differ markedly from those of larger particles of the same substance. Since the typical diameter of an atom is between 0.15 and 0.6 nm, a large fraction of the nanoparticle's material lies within a few atomic diameters from its surface. Therefore, the properties of that surface layer may dominate over those of the bulk material. This effect is particularly strong for nanoparticles dispersed in a medium of different composition since the interactions between the two materials at their interface also becomes significant.



Idealized model of a crystalline nanoparticle of platinum, about 2 nm in diameter, showing individual atoms.

Nanoparticles occur widely in nature and are objects of study in many sciences such as chemistry, physics, geology and biology. Being at the transition between bulk materials and atomic or molecular structures, they often exhibit phenomena that are not observed at either scale. They are an important component of atmospheric pollution, and key ingredients in many industrialized products such as paints, plastics, metals, ceramics, and magnetic products. The production of nanoparticles with specific properties is a branch of nanotechnology.

NANO CLUSTERS

Nanoclusters are atomically precise, crystalline materials most often existing on the 0-2 nanometer scale. They are often considered kinetically stable intermediates that form during the synthesis of comparatively larger materials such as semiconductor and metallic nanocrystals. The majority of research conducted to study nanoclusters has focused on characterizing their crystal structures and understanding their role in the nucleation and growth mechanisms of larger materials. These nanoclusters can be composed either of a single or of multiple elements, and exhibit interesting electronic, optical, and chemical properties compared to their larger counterparts.

Materials can be categorized into three different regimes, namely bulk, nanoparticles and nanoclusters. Bulk metals are electrical conductors and good optical reflectors and metal nanoparticles display intense colors due to surface plasmon resonance. However, when the size of metal nanoclusters is further reduced to form a nanocluster, the band structure becomes discontinuous and breaks down into discrete energy levels, somewhat similar to the energy levels of molecules. This gives nanoclusters similar qualities as a singular molecule and does not exhibit plasmonic behavior; nanoclusters are known as the bridging link between atoms and nanoparticles. Nanoclusters may also be referred to as molecular nanoparticles.