NANOMATERIALS

5.1-INTRODUCTION

The word "nano" is derived from a Greek word meaning dwarf or extremely small and means a billionth (10^{-9}) part of a unit. A nanometre or nm is one thousand millionth of a metre, i.e., 1 nm = 10^{-9} m = 10^{-3} μm = 10 Å.

CLASSIFICATION OF NANO MATERIALS

Nanomaterials can be classified on the basis of origin, dimensions and their structural configuration.

On the basis of the *dimensions,* nanomaterials also can be divided into zero dimensional, one dimensional, two dimensional and three- dimensional nano materials as shown in figure 6.1.
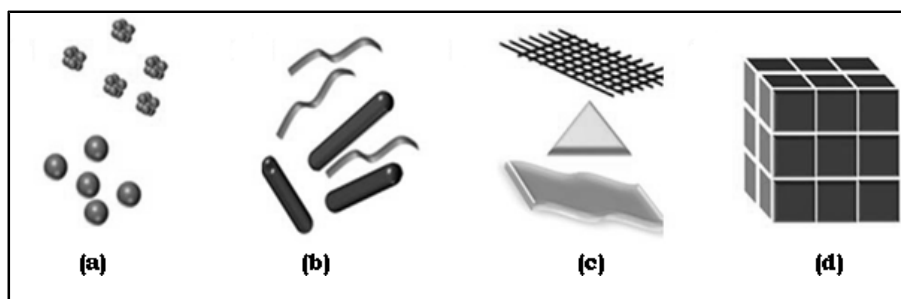

Fig.6.1: Different dimensional Nanomaterials (a) 0-D spheres and clusters, (b) 1-D nanofibers, wires and rods, (c) 2-D films, networks, (d) 3-D nanomaterials.

- *Zero dimensional(0-D)*:In these nanomaterials, all the dimensions are measured within the nanoscale. Metallic nanoparticles including gold and silver nanoparticles and semiconductor such as quantum dots are the perfect example of this kind of nanoparticles. Most of these nanoparticles are spherical in size and the diameter of these particles will be in the range of 1-50 nm.
- *One dimensional(1-D):*In these nanostructures, one dimension of the nanostructure will be outside the nanometer range. These include nanowires, nanorods, and nanotubes. These materials are long (several micrometer in length), but with diameter of only a few nanometers.
- *Two dimensional(2-D)*:In this type of nanomaterials, two dimensions are outside the nanometer range. These include different kinds of nano films such as coatings and thin-film-multilayers, nano sheets or nano-walls. The area of the nano films can be large (several square micrometer), but the thickness is always in nano scale range.
- *Three Dimensional(3-D)*: All dimensions of these are outside the nano meter range. These include bulk materials composed of the individual blocks which are in the nanometer scale (1-100 nm), dispersions of nanoparticles, bundles of nanowires and nanotubes as well as multi-nanolayers etc.

NMs classification based on dimensionality

| **0D**
Nanospheres,
clusters | **1D**
Nanotubes,
wires, rods | **2D**
Thin films, plates,
layered structures | **3D**
Bulk NMs,
polycrystals |

Quantum dots — Metal nanorods, Ceramic crystals — Carbon coated nanoplates — Liposome

Fullerenes — Carbon nanotubes, Metallic nanotubes — Graphene sheets — Polycrystalline

Gold nanoparticles — Gold nanowires, Polymeric nanofibers, Self assembled structures — Layered nanomaterials — Dendrimer