2-The importance of Nano science and its properties:

There are many reasons why the Nano scale has become so important, including :

1- The quantum mechanical (wave) properties of electrons within a material change at the Nano scale.

2- Depending on the Nano scale design of the material, its microscopic and macroscopic properties can change. When a material is manufactured at the Nano scale, its properties, such as strength, hardness, conductivity, and others, will change. For example, a metal can transform into a semiconductor or insulator when prepared at the Nano scale without changing its chemical composition.

3- Advances in Nano science and technology will allow us to place man-made Nano scale objects inside living cells. It will also make it possible to create new materials using nature's self-assembly capabilities. This will certainly be a powerful combination of biology and materials science.

4- Nano components have a very high surface-to-volume ratio, making them ideal for use in composite materials and reactive systems, drug delivery, and chemical energy storage (such as hydrogen and natural gas).

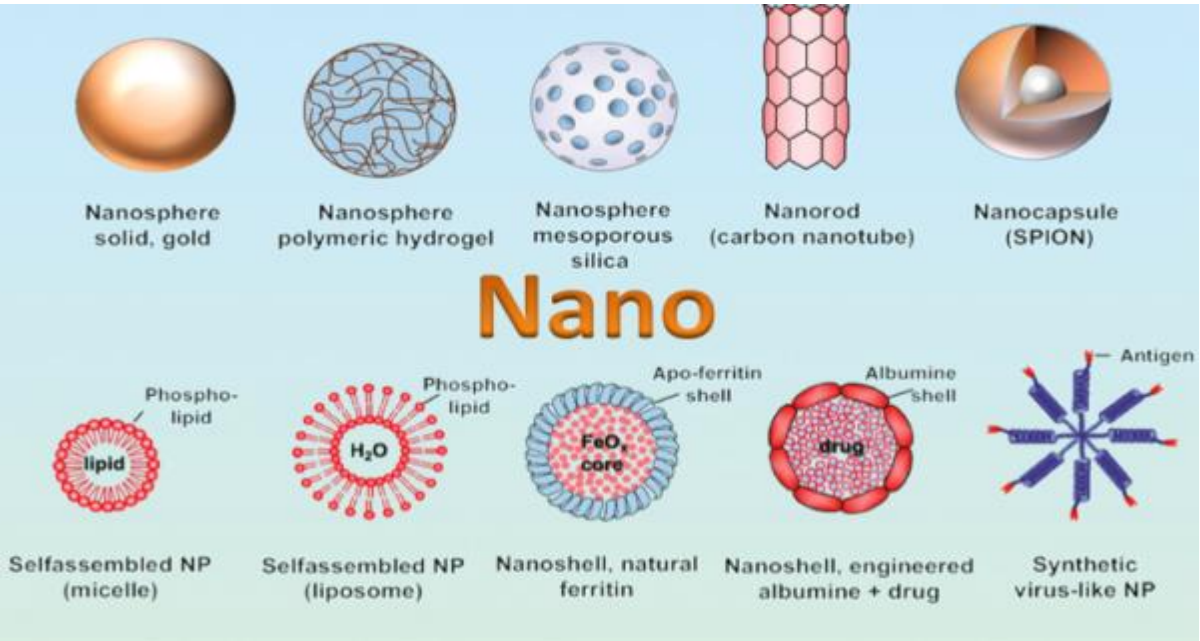


3 - Types of Nano materials :

Nanomaterial's are primarily divided into groups based on the number of dimensions at the Nano scale:

zero-dimensional (0D), such as nanoparticles;
one-dimensional (1D), such as nanotubes and Nano rods;
two-dimensional (2D), such as grapheme;
and three-dimensional (3D),
such as nanostructures extending in all dimensions.

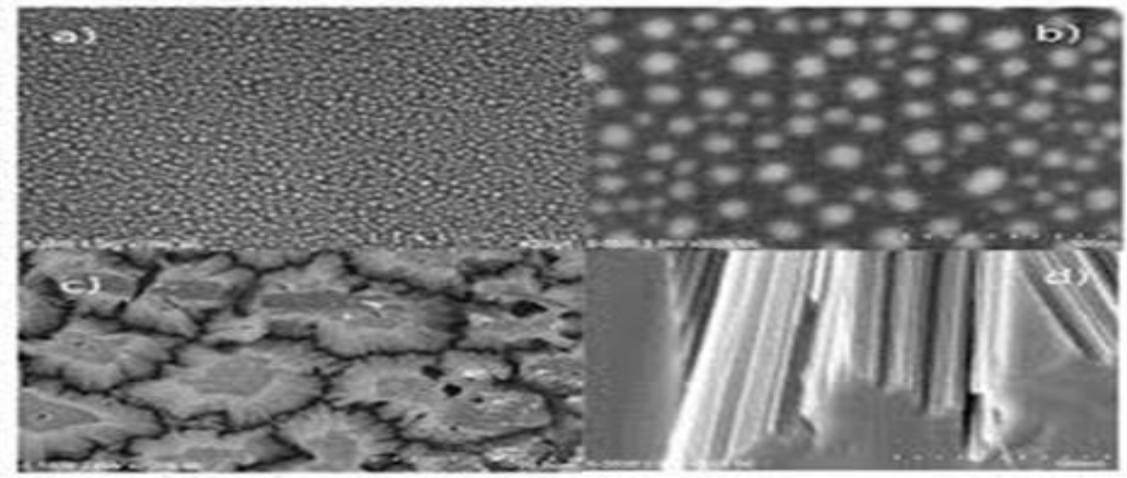
They can also be classified based on their chemical composition (carbon, metallic, polymeric, ceramic) or by their shape and origin.



3 -1 Some forms of nanomaterial's :

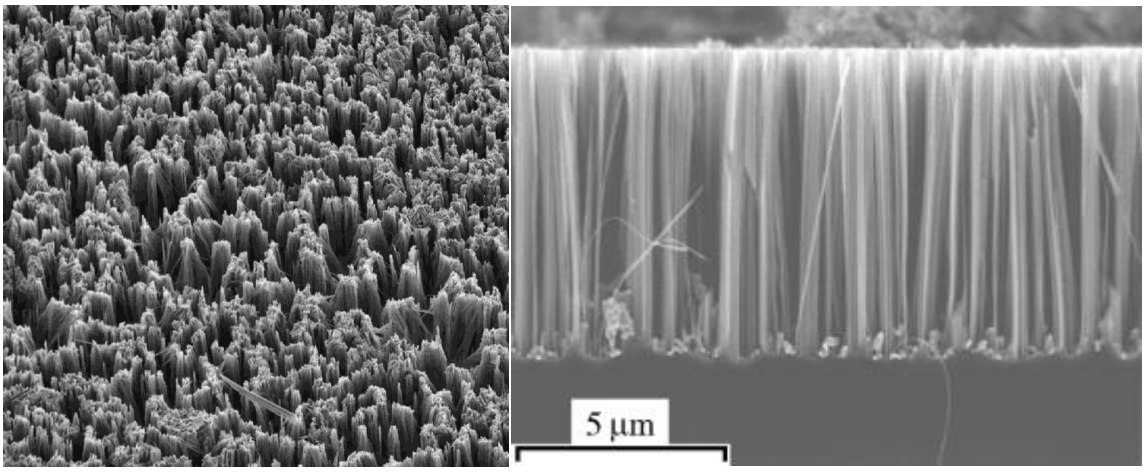
A - Nanoparticles:

Nanoparticles can be defined as an atomic or molecular assembly ranging in number from a few atoms (molecule) to a million atoms linked together in an almost spherical shape with a radius of less than (100 nm). For example, a particle with a radius of one nanometer will contain (25) atoms, most of which are on the surface of the body.
The shape of the particles (hexagonal, spherical, and triangular) is important in nanomaterial's , as a change in shape leads to a change in the properties of the material.
In general, when the particles reach the Nano scale in one dimension, they are called quantum wires.



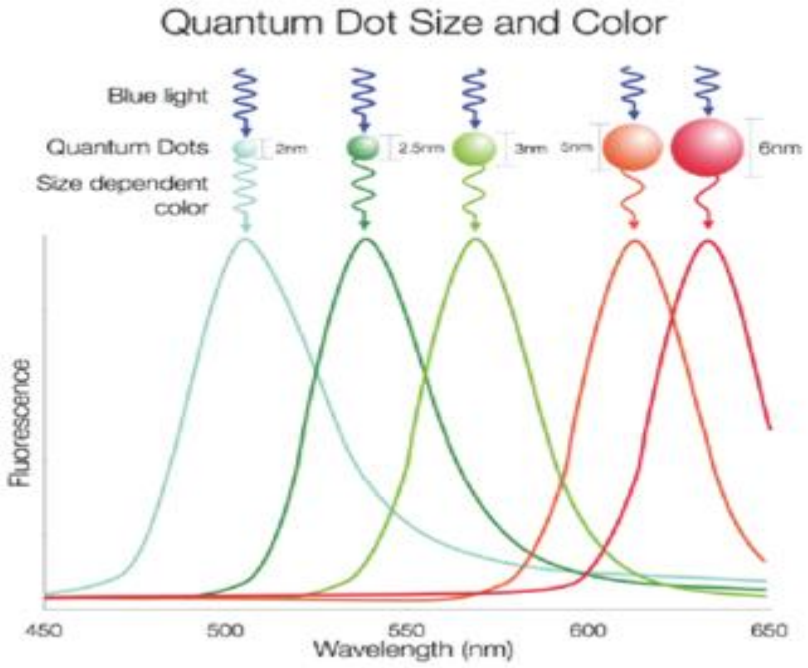
3 – 2 Nanowires :

Are wires with very small diameters, as their length-to-width ratio exceeds (1000) times, so they are classified as one-dimensional materials and are superior to traditional (three-dimensional) wires because the electrons in them are quantitatively confined in one side direction, which makes them occupy specific energy levels that differ from those wide levels found in bulk materials. Because they are subject to quantum confinement based on quantum mechanics, they have electrical conductivity with specific values. They do not exist in nature, but are manufactured in the laboratory, including metals (such as nickel, silver, and platinum), semiconductors (such as silicon, gallium nitrate, and indium phosphate), and insulators (such as silicates and titanium oxide). They are also in shapes, such as spirals or pentagonal symmetrical shapes. They are mostly manufactured by etching a large wire or bombarding a large wire with high-energy particles, in addition to other methods.



3 – 3 Quantum dots:

Are a three-dimensional semiconductor nanostructure with dimensions ranging from (2-10 nm), which corresponds to (10) to (50) atoms per diameter or approximately (100) to (100,000) atoms per volume of a single quantum dot. A single quantum dot confines conduction band electrons and valence band holes or excitons and exhibits a quantized energy spectrum.



3 -4 Nanorods

Can be defined as structures with diameters of nanometers in length ranging from one nanometer to a micron and are mostly made of

semiconductors and metals and complex technologies (VLS) associated with what are known as catalysts. The rods in their nanostructure take shapes similar to their primary network but with larger extended geometric dimensions, and sometimes when they meet at a single base they form what is known as a tripod. The rods with multiple shapes are characterized by unique optical mechanical properties in addition to their electrical properties that qualify them for use in various industrial applications, especially with regard to the manufacture of transistors and solar cells.