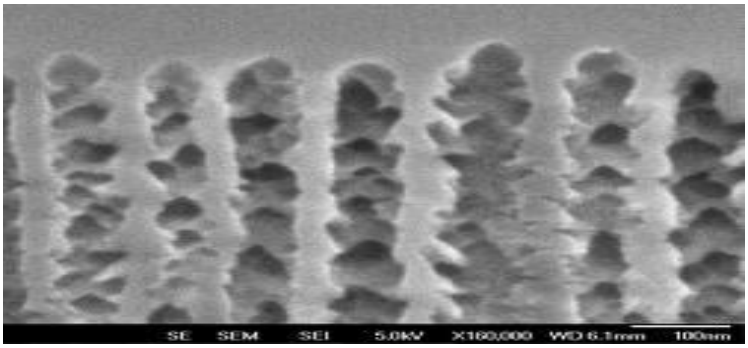
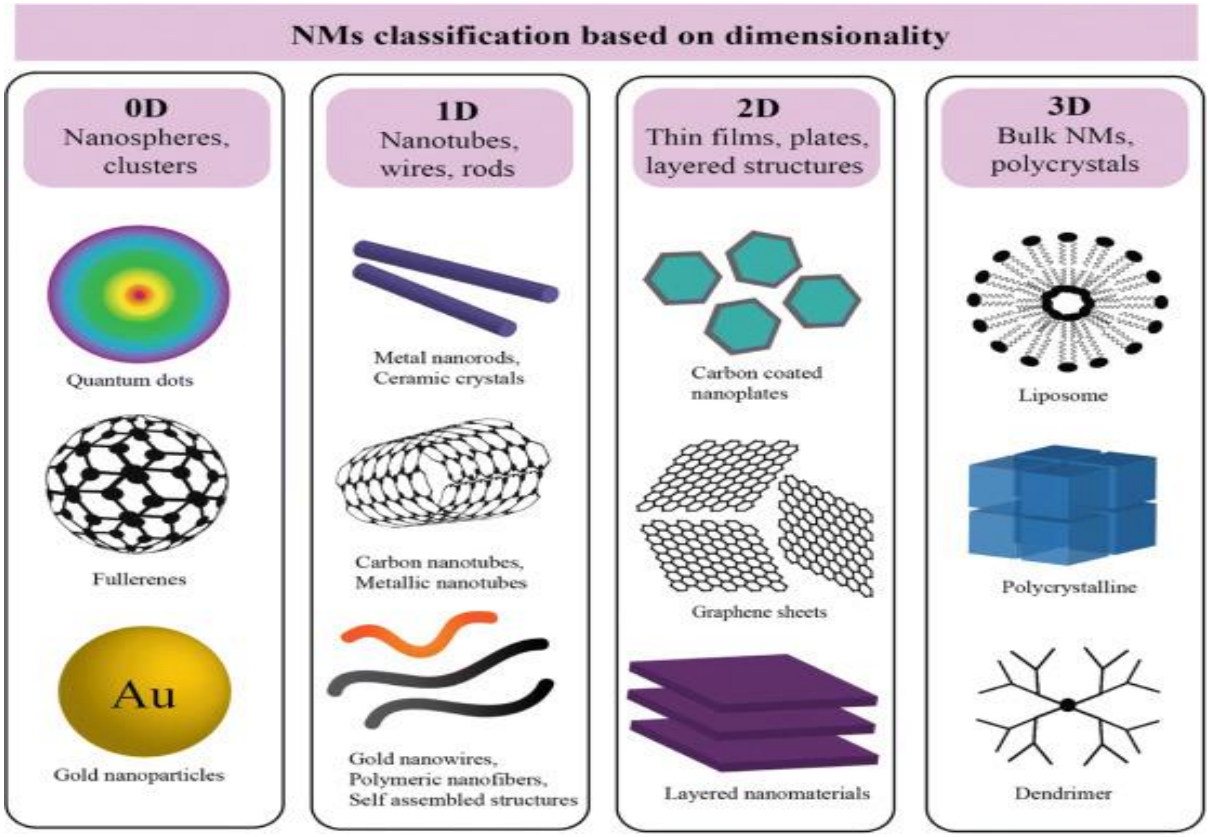


3 – 5 Nano crystals ;

Are crystals of elements and compounds on the Nano scale, in which the atoms are evenly spaced and exhibit properties that differ from those of larger materials (crystals). Their crystal structure may be different or identical to that of larger-sized equivalents. Nano crystals made from metals or semiconductors have many important applications, including optoelectronics, where they have the ability to change the wavelength of light. They also have other applications in solar cells and light-emitting diodes.



4 – Types of Nano Materials :

There are three different categories of Nano materials :
1- discrete Nano materials. (DN materials).
2-Nano device materials . (ND materials).
3- Nano scale materials. (BN materials).
• Discrete nanomaterial's :
are physical elements that are intrinsically (1–10) nanometers in size in one dimension (examples include nanoparticles and Nano fibers such as carbon nanotubes).
• Nano scale device materials :
are physical elements at the Nano scale embedded in devices, typically as thin films (e.g., the thin layer of metal oxide used in the fabrication of some semiconductors).
• Bulk nanomaterial's :
are materials that are available in large quantities (defined here as sizes of at least 3 mm) and yet have a structure that dominates the Nano scale.

Some typical micro- and nanomaterial's that have a significant impact on the development of micro- and nanotechnologies will be presented.

1- Carbon nanotubes CTNs :
They are one of the most important Nano materials for their applications in nanotechnology, electronics, optics, and other fields of materials science due to their unique properties. Carbon nanotubes are among the strongest and toughest materials discovered to date in terms of tensile strength and elastic modulus. They also exhibit high thermal conductivity, and all have unusual electrical properties due to the symmetry and unique electronic structure of grapheme.

2- Zinc oxide ZnO :
is one of the most important semiconductor oxides due to its distinctive properties and applications in transparent conductive oxide materials and

gas sensors. ZnO Nano belts were obtained by evaporating metal oxide powders at high temperatures.
3- Aluminum Al , Silver Ag , Gold Au and Copper Cu :
are the most common materials for metallizing integrated circuits. Aluminum, silver, and copper films can be easily obtained by evaporation, and micro- and Nanomaterial's for each of these are manufactured using different methods .

4 -The Physics of Low-Dimensional Semiconductors:
Advances in solid-state physics have been characterized by a shift from large crystals to small crystals , which have at least one dimension in the range (1-100 nm) . The change in dimensions affects the properties of the electron in the semiconductor , such as the dragline wavelength and the particle's wave-like behavior . The decrease in crystal size leads to a greater separation of energy levels and an increase in the effective energy gap, which leads to the emergence of new physical properties due to quantum effects such as the quantum Hall effect, quantum conductance oscillations, and other properties necessary for building a semiconductor .

5 - Methods for achieving Nano scale dimensions:

The process of manufacturing materials at the Nano scale can be accomplished in two ways:
A - The first is self-assembly, also known as the bottom-up approach, in which nanomaterial's Self-assembly is a "bottom-up" approach in nanotechnology where individual atoms, molecules, or small particles spontaneously organize into larger, ordered nanostructures through chemical and physical forces. This method involves building structures from the "bottom," such as from individual components, into complex, functional Nano scale materials, a process often driven by interactions between the constituent particles.
The first is self-assembly, also known as the bottom-up approach, in which nanomaterial's are built atom-by-atom.

B - The second method is called the top-down approach, in which materials are sculpted to achieve their Nano scale dimensions.

