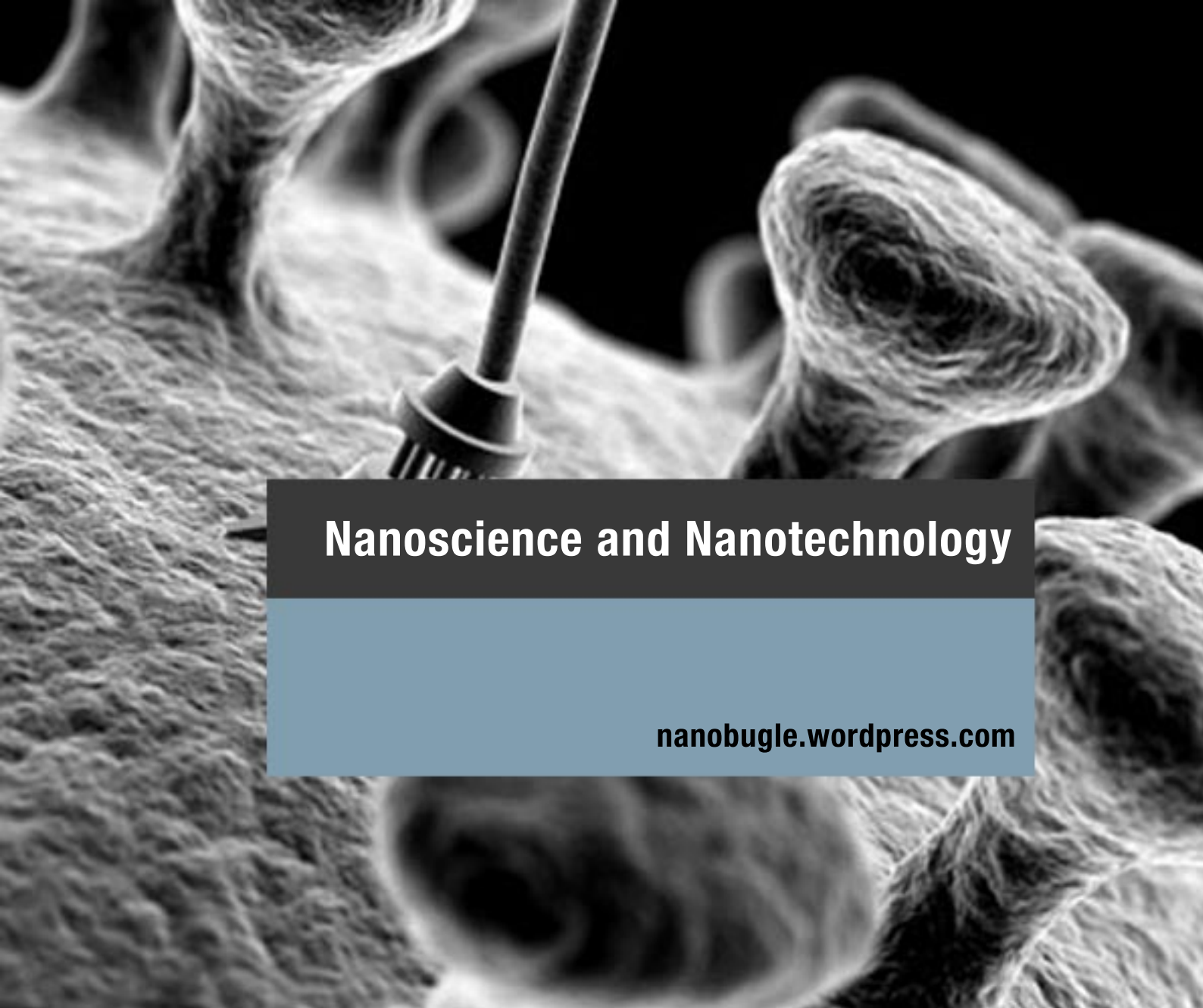

Nanoscience and Nanotechnology

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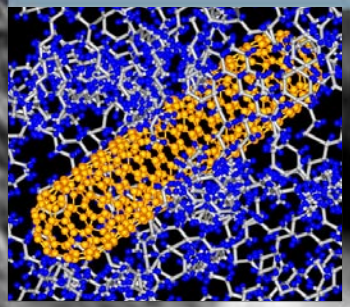
Nanoscience and Nanotechnology

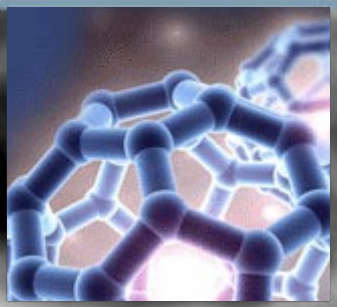
Introduction

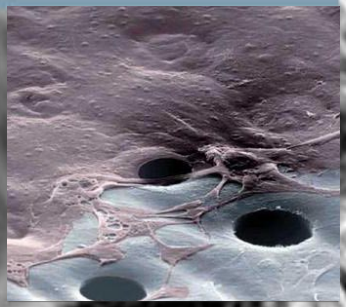
Nanoscience and Nanotechnology expressions come from the union of the prefix ‘nano’ with the terms science and technology.

The prefix ‘nano’ in both science and technology refers to a unit of 10^{-9} (one millionth of a unit in the European system, or one billionth of that unit in the American system). So for example, one nanometer is equal to 10^{-9} meters.

So that we get an idea of what the Nanoscale represents, let us think. The length of ten hydrogen atoms is one nm and a white blood cell is about 10,000 nm in diameter.







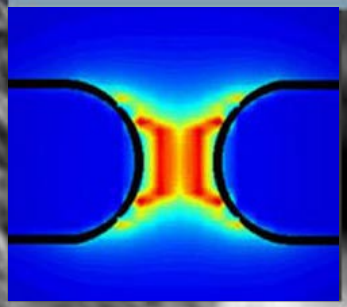
Nanoscience and Nanotechnology

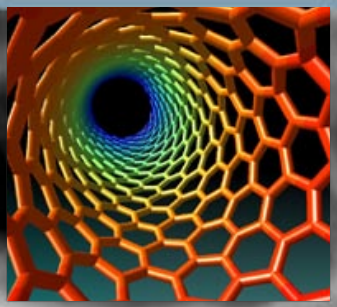
What changes?

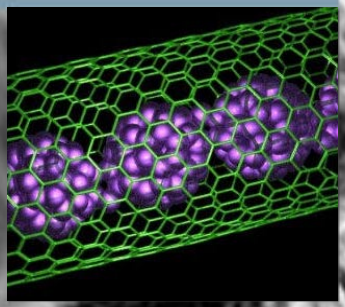
At Nanoscale, materials present significantly different properties from those with a larger scale.

The surface area of nanomaterials is much greater than the area of materials with the same mass but on larger scale, affecting their chemical, mechanical or electrical properties.

At nanoscale, quantum effects dominate the behaviour of material and affect its optical, electrical and magnetic properties.







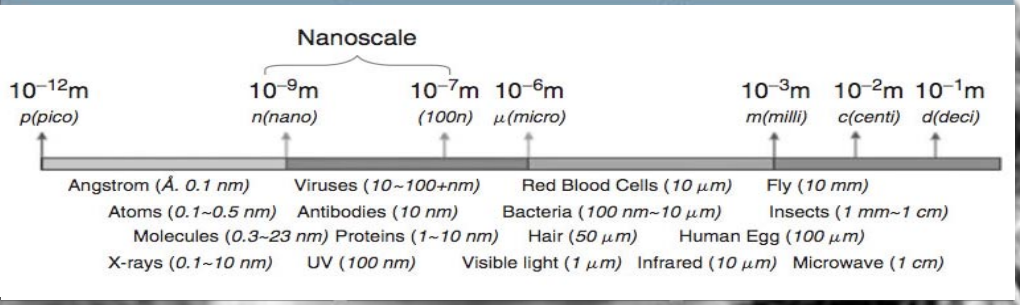
Nanoscience and Nanotechnology

Nanoscale

It is generally defined as the scale of sizes ranging from one atom to 100 nanometers.

Although there is no consensus on the definition of nanomaterials, we can adopt the one given by Yih, TC and Wei, C. (2005), which states that a nanomaterial is a material whose smallest dimension is less than 100 nanometers and 0.1 micrometers (m).

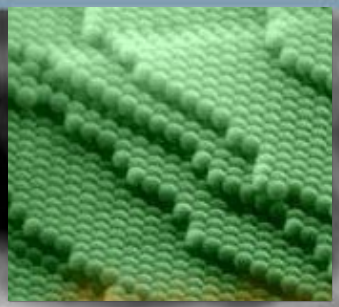
In some cases, this definition is included in materials that exceed this size (up to 1 micron or 1000 nm). However, regardless of the size, to be considering a nanomaterial it should present unique properties different from those of large scale. In general, a nanomaterial includes structures, devices and systems at the nanoscale.

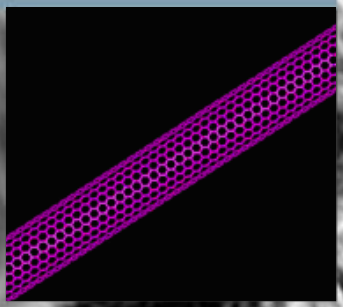


Nanoscience and Nanotechnology

Nanoscience

Nanoscience is concerned with investigating systems whose dimensions are smaller in the range of a few to about 100 nanometers.





Nanoscience and Nanotechnology

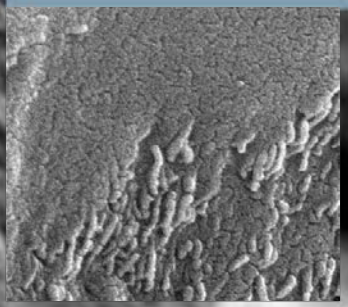
Nanotechnology

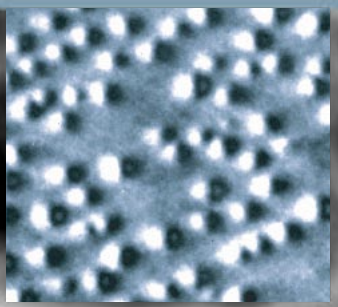
Nanotechnology usually refers to the ability to design and control structure of an object in the size range of nanometers.

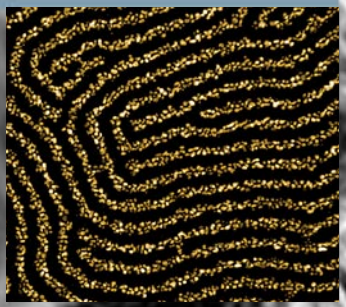
There are almost as many definitions of nanotechnology as areas covered, reflecting the fact that nanotechnology covers a broad spectrum of research areas and requires multidisciplinary and interdisciplinary efforts (Cao 2004).

The only feature common to the different activities is the tiny dimensions in which it operates.

It is possible to describe Nanotechnology as a design technology, manufacturing and applications of nanomaterials and nanostructures.



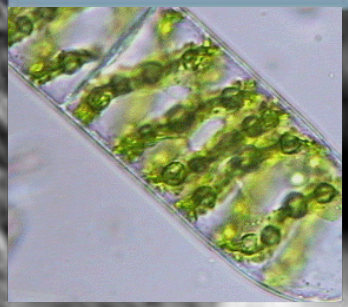


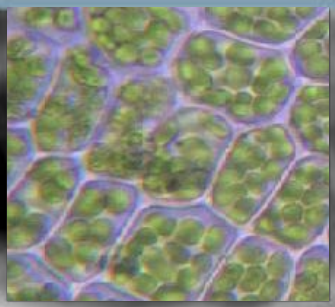


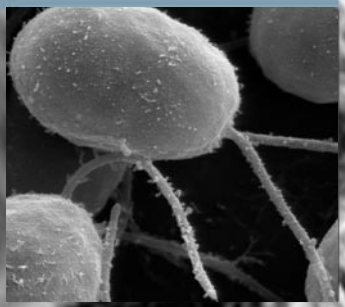
Nanoscience and Nanotechnology

Natural nanotechnology

Nanotechnology occurs naturally without the intervention of human beings. One example is the chloroplast.

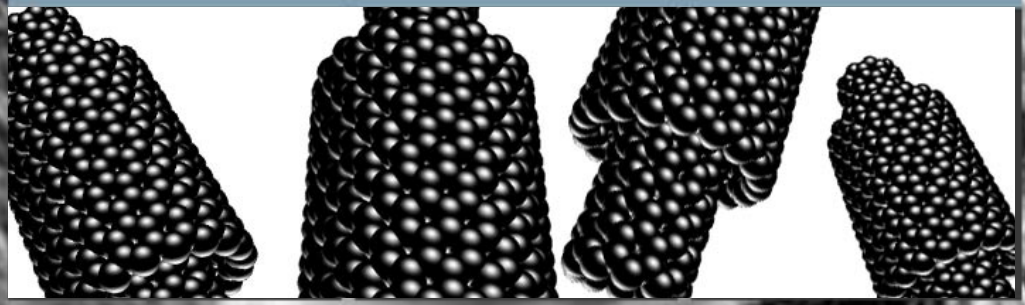






Nanotechnology and electronics

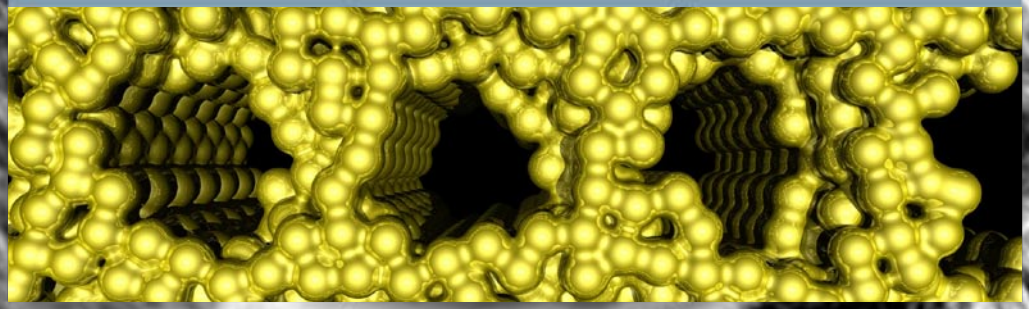
One of the main fields of nanotechnology is miniaturization of devices in the semiconductor industry.



Chemical Nanotechnology

For chemicals, nanotechnology is not an entirely new field, as many of the existing technologies used chemical processes at the nanoscale.

Chemical catalysts are typical of chemical nanotechnology that have existed for more than a century.

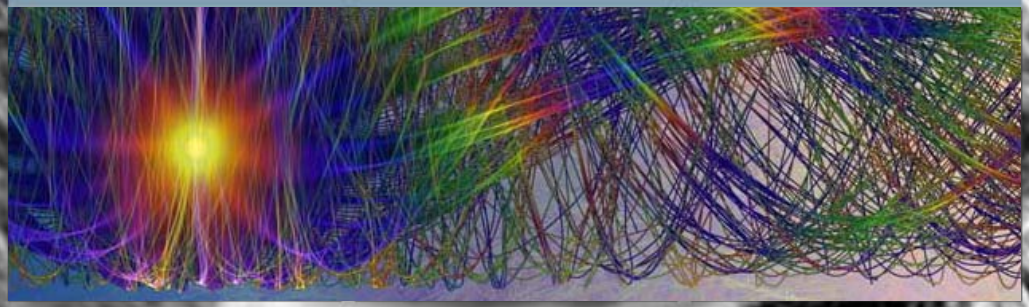


Nanoscience and Nanotechnology

Nanobiotechnology

Often nanobiotechnology studies elements existing in nature to produce new devices.

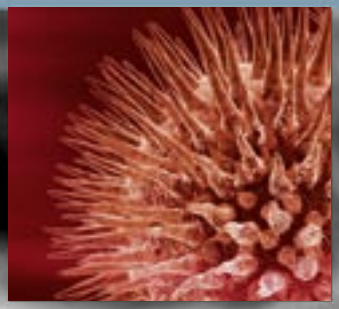
It covers the use of biological systems optimized by evolution to produce functional nanostructures and mesoscopic architectures comprised of organic and inorganic materials.

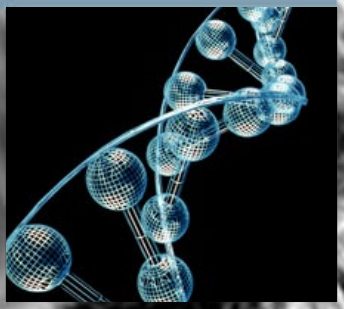


Biomedical Nanotechnology

Nanotechnology and nanomaterials have a wide field of application in biomedicine, especially in areas such as biomedical diagnosis, drug and prostheses and implants.

The application of nanotechnology to diagnosis and therapy of cancer is receiving much attention from the scientific community that sometimes considers it a special branch of nanotechnology.



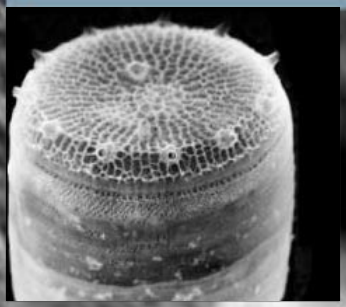


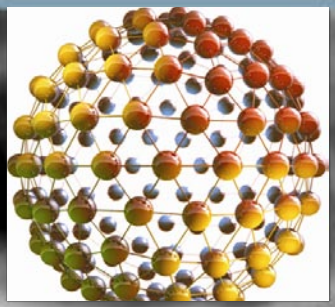
Synthesis of nanomaterials

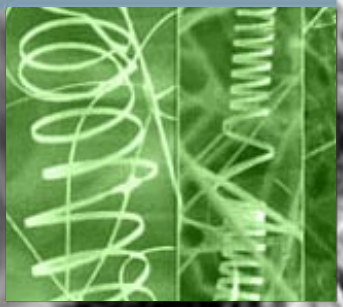
Top-down Approach

In general, we can say that is an extension of the lithography. The main challenge is creating accurately and efficiently ever-smaller structures.

It begins with a block of material and the specialists reduce it to the desired shape at the nanoscale by controlled etching, elimination and layering of the material.







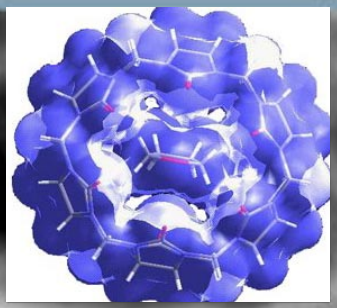
Synthesis of nanomaterials

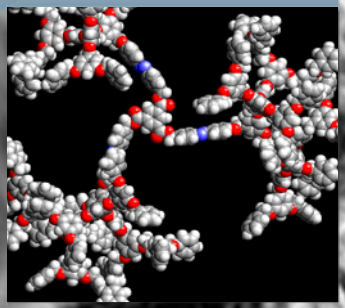
Bottom-up Approach

Materials are produced efficiently and effectively controlling the arrangement of atoms, molecules, macromolecules and supramolecules.

The reduction of Gibbs free energy aims this method. The production of nanomaterials occurs in a state closer to thermodynamic equilibrium state.

The main challenge is how to build structures that are of sufficient size and quantity to be used materials in practical applications.

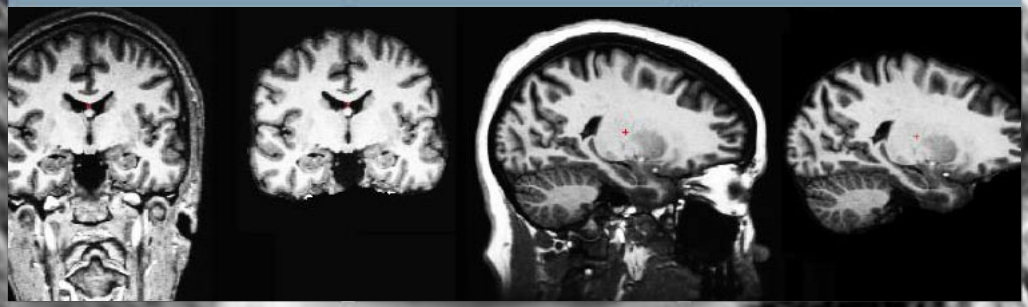




Synthesis of nanomaterials

Hybrid Approach

In many cases, the combination of the methods top-down and bottom-up so that it avoids the limitations of the two is the optimal solution.



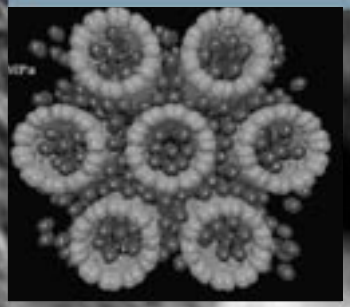
Types of nanomaterials

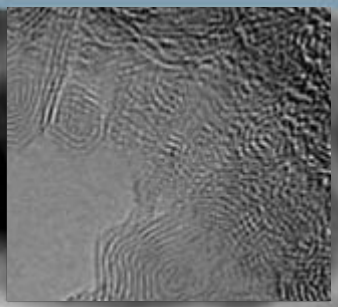
Carbon-Based Nanomaterials

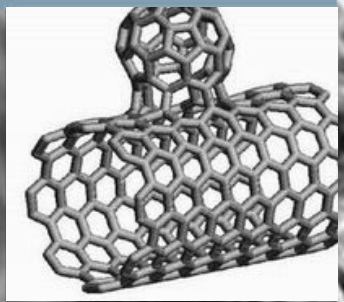
These nanomaterials are composed mostly of carbon and tend to take forms such as hollow spheres, ellipsoids, or tubes.

Carbon nanomaterials with spherical or ellipsoidal shape are known as fullerenes, while the cylinders are called nanotubes.

These particles have many potential applications, including the development of improved coatings and films, lighter and more resistant materials and various applications in the field of electronics.



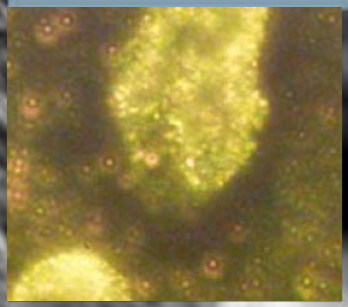


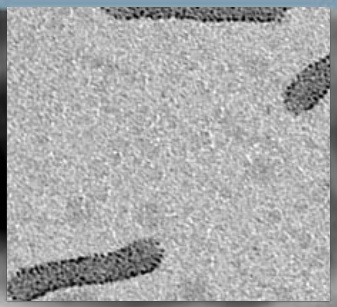


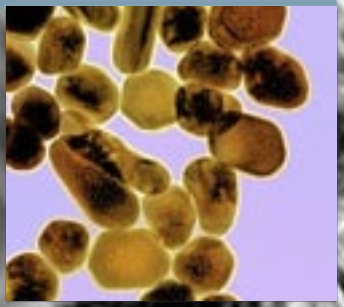
Types of nanomaterials

Nanomaterials based on metal

These nanomaterials include quantum dots, silver and gold nanoparticles and metal oxides such as titanium dioxide.







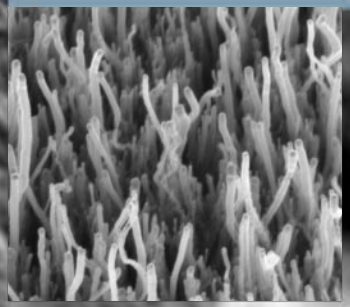
Types of nanomaterials

Dendrimer

These nanomaterials are nanometer-sized polymers built from branched units.

The surface of Dendrimers has a number of chain ends that can be customized to perform specific chemical functions. This property could also be used for catalysis.

Furthermore, because the three-dimensional Dendrimers contain interior cavities to introduce other molecules, it is useful for drug administration.

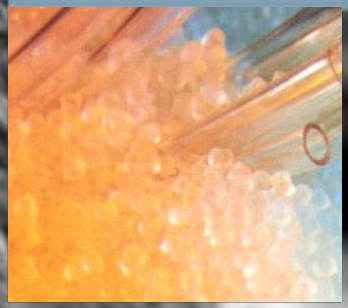


Types of nanomaterials

Compounds

The compounds combine nanoparticles with other nanoparticles or with larger materials.

Nanoparticles such as clay at nanoscale, are already being added to many products, from auto parts to packaging materials, to improve their mechanical, insulating or protective.



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