Nanotechnology

In recent years, Nanotechnology has become one of the more significant and exciting new fields at the interface of Chemistry, Physics, Engineering and Biology. It shows great a number of achievements that will change the direction of technology in a large field of products such as nanotransistor, nanorebots, nanofood, eyeglasses, plasma displays, baseball and many others. According INAS (2010), The power of nanotechnology is rooted in its potential to transform and revolutionize multiple technology and industry sectors, including aerospace, agriculture, biotechnology, homeland security and national defense, energy, environmental improvement, information technology, medicine, and transportation.

Nanotechnology was discovered in 1959 by the physicist Richard Feyman. He is the first scientist who proposed the concepts of Nanotechnology. Nanotechnology is the branch of technology that deals with dimensions of less than 100 nanometers. It is science, engineering and technology at the nanoscale. Using nanoscale (nm) is very an important in Nanotechnology. It means the size range of about (1 to 100) nm, where vast numbers of fundamental structures ions, atoms and molecules such as carbon nanotube are formed.

Modern uses of Nanotechnology started at of the 1999s, not proficiently with common consumer products. These products ranged everywhere from car bumpers to golf sticks and socks. Today, Nanotechnology has enormous potential to get benefits and attracts increasing investment from Governments and businesses in different countries. The cosmetics and food industries routinely use passive nonmaterial in their products. For instance, Nanotechnology is widely used in microelectronics, with transistors in computer chips.

The Properties of Nanoparticles

Nanoparticles have a very large surface area for their size or volume. This gives them different properties and uses compared to larger materials which are made from the same substance. Nanoparticles are used in sunscreens, sports equipment, drug delivery coatings and medicine. Future uses include catalysts, computers and building materials.

Nanoscience

Nanoscience is the science of very small particles. Nanoscience looks at the properties of nanoparticles. These are particles within the range of 0·1nm to 100nm. The name 'nano' means 10^{-9}. A nanometre is one millionth of a millimetre. It is written nm. 1nm = 0·000000001 metres.

The table below shows the sizes of some things listed in the left column. The bottom four are in the range of nanoparticles.

Object	Size in Nano metres
Human Hair Width	50,000
Wavelength of Violet Light	400
Cold Virus	30
Small Protein	10
Buckyball	1
Water Molecule	0·2

Importance of nanoscale

The nanoscale, a nanometre (nm) is the universal unit (IS) of length measurements, that is 1 billionth of a meter (10^{-9} m). Nanoscale measuring is very important because at this scale properties of materials can be different from those at a large scale. For instance, gold molecules are not active. Therefore, it is used as a jewellery. However, at a nanoscale, gold molecules become very active and it used in medicine for cancer treatment. Figure (1) shows examples at nanoscale such as virus is about 200 nm in size, and a water molecule is nearly 0.3 nm. The properties of molecules can be changed at the nanoscale because nanomaterials have a comparatively large surface area per unit/volume when compared to the same mass of material produced in microscopic form. This can make these more chemically reactive. Many materials can be produced that are nanoscale in one dimension such as very thin surface coatings (semiconductor, metal, carbon). Nanotechnology looks at the new uses of these small particles. There are many examples of nanoparticles

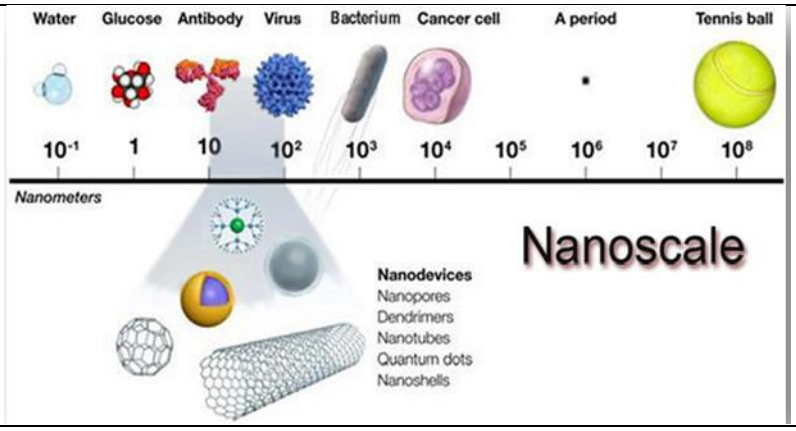


Figure 1: The nanoscale

Biomimetic Materials

In the 1950s Otto Schimdt described biology→ technology transfers as biomimetic. Organic syntheses were the initial realm of biomimetic chemistry, but its impact has progressed to bio-inorganic interfaces with benefits to materials design. With evolution many living plant and animal species have constructed species-specific biocomposite structures that have nano-architectures whose green processing is the envy of materials scientists. In biomimetic materials, researchers learn from (and replicate) nature's three-dimensional self-assembled biotemplates (whether there be 8.7 million or 20 million species on earth) through transformation of hybrid nanostructures to develop novel inorganic nanostructures Nanochemistry aims thereby to extend the traditional length scales of synthetic chemistry. Applying lessons from nature allows the synthesis bio-inspired, biomimetic and biominerals materials of ever-more fascinating complexity and properties.

For example, studies of the surfaces of lotus leaves that emerge pristine and clean from muddy waters suggested this is a result of their surface filaments with inherent surface roughness and structural/chemical anisotropy (10<aspect ratio<20) and this led to 'lotus leaf' paint surfaces that are antibiotic, antifouling, self-cleaning and pollution controlling.

All biological materials contain water at some concentration, which is critical to organization and functioning, and hierarchy and can provide biomimetic solutions to engineering materials. Biomimetic materials are thought to have been limited by our ability to replicate biological systems).

The achievements

In the 21st century, global investment in Nanotechnology have increased to over $ 3 billion WorldWide in 2003.Figure (2) shows that the countries spent around 5 billion. Because of Nanotechnology is bringing to the innovation table that cannot be ignored by financial and economic planners. It has more potential applications and over 800 commercial products used Nanotechnology in medicine, industry and sports.

Table I Government expenditure on nanotechnology R&D (US$ million)

	1998	1999	2000	2001	2002
W. Europe	151	179	200	225	285
Japan	135	157	245	550	753
USA	190	255	270	422	518
Others	83	96	110	380	?
Total	559	687	825	1,577	?

Source: Roco (2001)

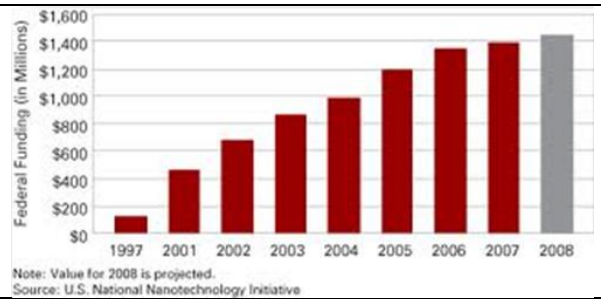
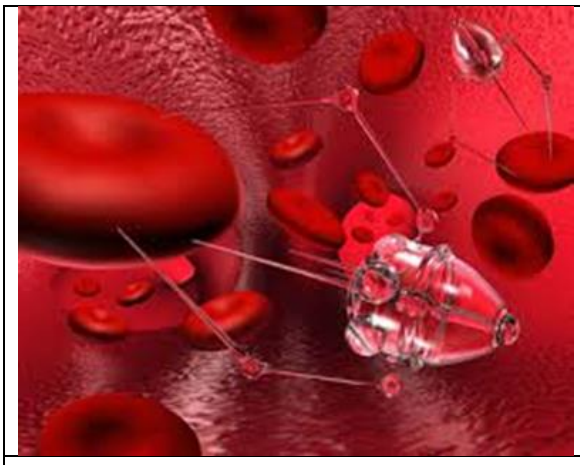


Figure 2: Governments expenditure on Nanotechnology (Schulte, 2005).

Nano Medicine

Medicine and Biology have many of applications in Nanotechnology such as Bio chip and carbon nanotubes which shown in figure (3). It can be used in Medicine for the replacement of body parts as valves, retina, heart and hip joints. Bio chip was used in surgical instrumentation, diagnosis and drug delivery. Moreover, several applications are drug delivery, biosensing antigen recognition and DNA hybridization, due to their unique properties. Also, the penetration power of carbon nanotubes into cells offers the potential of using carbon nanotube as vehicles for the delivery of medicine and antibiotic molecules without side effects. a model for making carbon nanotubes discovered a delivery mean of fluorouracil (anticancer drug) by examining the interaction of the fluorouracil radicals on the surface of single-walled carbon nanotubes.



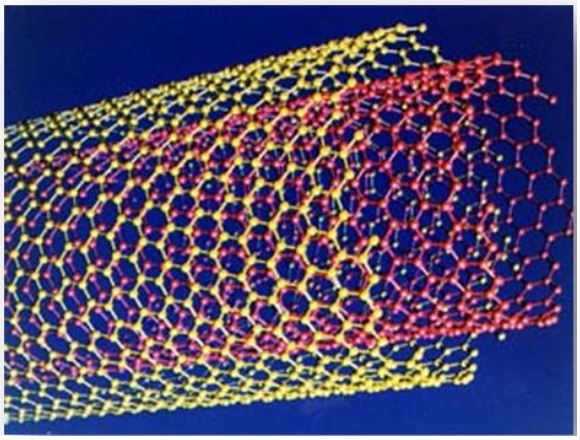


Figure3: Cancer treatments would use gold particles to carry anticancer drugs straight to the cancer and Carbon nanotube.

Nanotechnology is increased knowledge of human body and drug delivery development. For example, gold and iron nanoparticles are used in cancer treatment by nanotransistor, nanofilters. Nano medicines also greatly reduce the damage treatment such as chemotherapy does to patients' healthy cells. Also, tissue engineering is done using nanotechnology such as cosmetic surgery or body sculpting (change your appearance). It used medical robotic, tools and imaging in this field. Finally, sun cream used based on mineral nanoparticles like Titanium dioxide which have a comparable UV protection properly as the bulk material but lose the comically undesirable whitening as the particle size is decreased. Nanotechnology promised in futuristic applications by using nanorobotics such as microscopic robots that assemble other machines or travel inside human body to deliver drugs or do microsurgery.

Silver has been used historically for both jewelry and medicine. Silver has been known to have both an anti-bacterial property and an anti-fungal property. Anti-bacterial means that it kills bacteria (or stops them reproducing). Anti-fungal means that it kills fungi (or stops them reproducing). For over 2000 years silver has been used to purify and today some people use water filters which contain silver. Before the development of antibiotics, a thin layer of silver was applied to cuts and wounds to prevent infection and speed up the healing process. An antibiotic is a substance that kills bacteria (or stops them reproducing). In recent years there has been an increase in the number of bacteria that are resistant to antibiotics. This means that they are no longer killed by antibiotics. Silver is now being used more to prevent infection.

Nano silver is the name given to nanoparticles of silver. Only a very thin coating of nano silver needs to be used. The very high surface area of this type of coating gives a big improvement in the properties of silver that prevent bacterial or fungal growth. Nano silver is used in dressings for injuries caused by burns, and wounds caused by surgery.

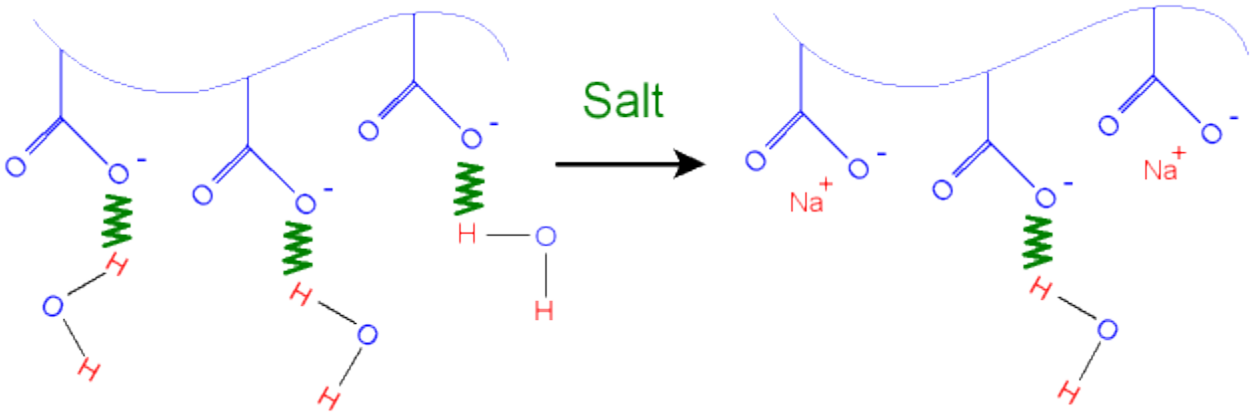
Hydrogels

Hydrogels are used to make soft contact lenses, nappies, wound dressings and drug delivery systems. Hydrogel used for a Wound Dressing. A wound dressing is put over a cut in the skin to help the skin heal. The hydrogel is applied as a thin layer which is moist and soothing.
It stops the wound drying out and protects it from infection. The hydrogel can control bleeding and does not stick to the surface so it can be removed easily without damaging the skin.

In drug delivery the hydrogel can release an antibiotic (or other drug) at a controlled rate to the body tissue beneath. This is better than taking an antibiotic as a pill by mouth which has an effect on the whole body and increases the chance of a bad reaction to the drug.

The hydrogel is called a carrier when it is loaded with a drug. As the swelling of the hydrogel increases, the chains of the cross linked network move further apart and the drug can diffuse more quickly through the hydrogel to the skin.

The Structure of a Hydrogel with Salty Water. We shall look at how the hydrogel on the previous page changes in response to an increase in salt concentration. The chains in the uncoiled cross linked hydrogel attract water molecules by hydrogen bonding. As more salt (for example sodium chloride) is added to the hydrogel, the positive sodium ions take up places next to the negative oxide ions and there is less space for the water molecules as shown in the picture below.



This makes the hydrogel lose some water. The negative charges along the chain repel each other less in the presence of the sodium ions and so the chains become more coiled up. This also squeezes out water from the hydrogel. The result is that a small change in salt concentration can have a significant effect on the amount of water leaving the hydro

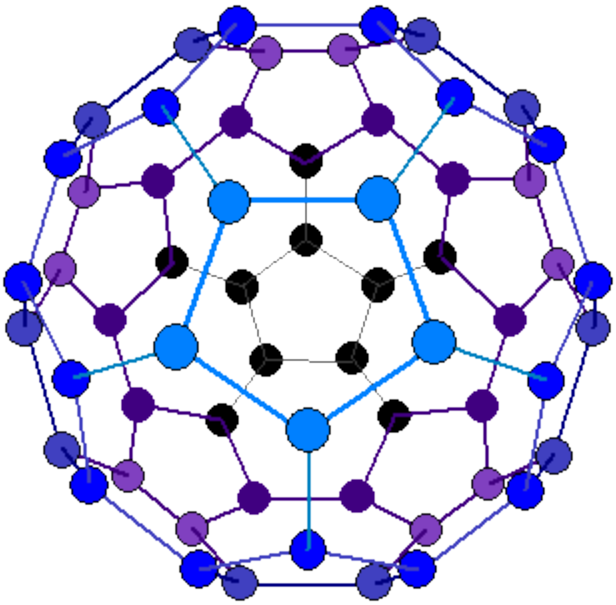
In industry:

There are many industry applications in Nanotechnology. Firstly, Bucky paper is used to make cars by Nanotechnology. Lighter and stronger materials are be of huge use to aircraft manufactures, leading to increased performance. When the weight is a major factor, Nanotechnology helps to reduce the size of equipment and thereby decrease fuel. Figure (4) shows types of cars which made by using Bucky paper. Bucky paper is an order of carbon nanotubes. A single carbon nanotube is nearly 200 x stronger than steel at 0.166 the weight. These carbon nanotubes can be arranged to strengthen specific properties. In addition, today, no need for traditional batteries because the surface of a Bucky paper car which shows in figure (4) stores energy, reducing weight and size. Bucky paper fuel cell is the relative amount of platinum used.

Figure.4 Bucky paper car.

Buckminsterfullerene

In 1985 a new allotrope of carbon (C_{60}) was discovered. Sixty carbon atoms form the shape of a ball like a football with a carbon atom at each corner of the 20 hexagons and 12 pentagons. Each carbon atom (shown below as a circle) has three bonds.



The size of the molecule is almost exactly 1nm in diameter. The ratio of the size of an ordinary soccer ball to the planet Earth is the same as the ratio of the size of a C_{60} molecule to a soccer ball. These are not called giant molecules because there are only sixty atoms.
A large number of these molecules can fit together to form a transparent yellow

solid called fullerite. This form of carbon was named after the American architect Buckminster Fuller, who was famous for designing a large geodesic dome which looked similar (sort of) to the molecular structure of C_{60}. Many other balls of carbon called fullerenes, have since been made, including C_{70}, C_{76}, and C_{84}. These molecules have become known as "buckyballs".

Fullerenes are used as catalysts and lubricants. They are also used in nanotubes for strengthening materials (for example sports equipment) and are sometimes used as a way of delivering drugs into the body.

Finally, companies have developed Nanotechnology solar calls that can be manufactured at significantly lower cost than conventional solar cells. Nanotechnology could help increase the efficiency of solar cells to around 40%. According to INAS (2010), nanofiltration which a strong influence of nanochemistry on waste-water treatment and air purification. Nanoporous membranes are suitable from a mechanical filtration. Nanofiltration is mainly used for removal ions or the separation of different fluids (ibid).

In sports:

Nanotechnology applications used at Olympic venues in Russia such as carbon fiber and nanoglass. At first, carbon fiber is used instead of fiberglass to make sleds. It is lighter and better weight distribution. In addition, carbon fiber is very aerodynamic to shed snow better (Sochi 2014 Olympic_Winter Games, 2014). Then, using nanoglass to make law-emission energy- saving glass. By applying special layers ranging in depth from (5 – 500) nm, a window become enable of retaining heat through a building. At the same time, maintaining a convenient environment inside when it is also warm outside. Means that, save up to 30 % of thermal energy in the building (ibid).

Figure 5 The applications on Nanotechnology.

Drawbacks:

Nanotechnology may be not the solution to many issues, and it could create many dangers. Molecular manufacturing can radically change the production industry. One of the drawbacks is the economic issues. For instance, molecular making could eliminate the needs of many jobs in the industry (European Commission, 2013). While this could seem beneficial, it would lead to an increase in unemployment rates. As a result, it has created social strife through an increasing wealth gap, misuse of molecular making may be used to make dangerous weapons. Moreover, many cleaning products use sliver nanoparticles (is a particle at least one dimension under 100 nm) (ibid).Theses particles enter into the environment. These silver nanoparticles are very poisonous, and it causes cancer. For example, Nano-pollutants could be cause cancer because these particles small enough to enter one's lungs and be absorbed by the skin.

Figure 6 Examples for Nanopollutants