Nanotechnology

(theoretical part)

Nanotechnology in theory

Nanotechnology is commonly considered to deal with particles in the size range <100 nm, and with the nanomaterials manufactured using nanoparticles.

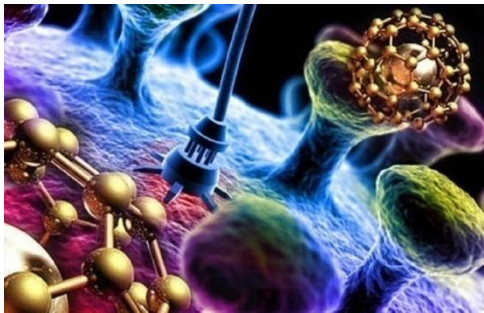
A nanometer is an extremely small unit of length—a billionth (10^{-9}) of a meter. Just how small is a nanometer (nm)? A single human hair is about 80,000 to 100,000 nm wide.

Who coined the term 'nanotechnology'?

The term was coined in 1974 by Norio Taniguichi of of Tokyo Science University to describe semiconductor processes such as thin-film deposition that deal with control on the order of nanometers. His definition still stands as the basic statement today: "*Nano-technology mainly consists of the processing of separation, consolidation, and deformation of materials by one atom or one molecule*."

Nanoscience and nanotechnologies are not new

In some senses, nanoscience and nanotechnologies are not new. Chemists have been making polymers, which are large molecules made up of nanoscale subunits, for many decades and nanotechnologies have been used to create the tiny features on computer chips for the past 20 years. However, advances in the tools that now allow atoms and molecules to be examined and probed with great precision have enabled the expansion and development of nanoscience and nanotechnologies.



Nanotechnology in practice

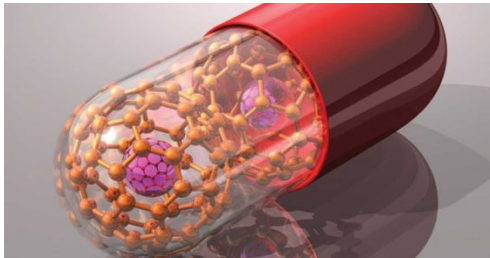
Nanotechnology is not microscopy. "Nanotechnology is not simply working at ever smaller dimensions," the National Nanotechnology Initiative says. "Rather, working at the nanoscale enables scientists to utilize the unique physical, chemical, mechanical, and optical properties of materials that naturally occur at that scale."

There are **four main types of intentionally produced nanomaterials**: carbon-based, metal-based, dendrimers, and nanocomposites.

The research and development of nanotechnology is very active globally, and nanotechnologies are already used in hundreds of products, including sunscreens, cosmetics, textiles, and sports equipment. Nanotechnology is also being developed for use in drug delivery, biosensors, and other biomedical applications. Further, nanotechnologies are also being developed for use in environmental applications, e.g., clean-up of environmental pollutants.

Nanotech equipment

Scientists and engineers working at the nanometer-scale need special microscopes. The atomic force microscope (AFM) and the scanning tunneling microscope (STM) are essential in the study of nanotechnology. These powerful tools allow scientists and engineers to see and manipulate individual atoms.



Nanotech and People

Hundreds of consumer products are already benefiting from nanotechnology. You may be wearing, eating, or breathing nanoparticles right now!

Clothing

Scientists and engineers are using nanotechnology to enhance clothing. By coating fabrics with a thin layer of zinc oxide nanoparticles, for instance, manufacturers can create clothes that give better protection from ultraviolet radiation, like that from the sun. Some clothes have nanoparticles in the form of little hairs or whiskers that help repel water and other materials, making fabric more stain-resistant.

Some researchers are experimenting with nanotechnology for "personal climate control." Nanofiber jackets allow the wearer to control the jacket's warmth using a small set of batteries.

Cosmetics

Many cosmetic products contain nanoparticles. Nanometer-scale materials in these products provide greater clarity, coverage, cleansing, or absorption. For instance, the nanoparticles used in sunscreen (titanium dioxide and zinc oxide) provide reliable, extensive protection from harmful UV radiation. These nanomaterials offer better light reflection for a longer time period.

Nanotechnology may also provide better "delivery systems" for cosmetic ingredients. Nanomaterials may be able to penetrate a skin's cell membranes to augment the cell's features, such as elasticity or moisture.

Athletics

Nanotech is revolutionizing the sports world. Nanometer-scale additives can make sporting equipment lightweight, stiff, and durable.

Carbon nanotubes, for example, are used to make bicycle frames and tennis rackets lighter, thinner, and more resilient. Nanotubes give golf clubs and hockey sticks a more powerful and accurate drive.

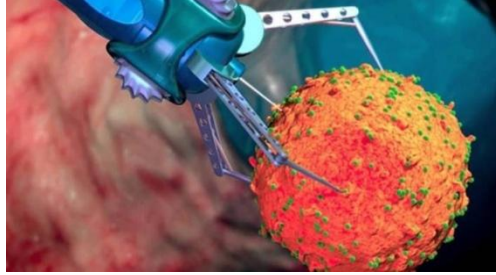
Carbon nanotubes embedded in epoxy coatings make kayaks faster and more stable in the water. A similar epoxy keeps tennis balls bouncy.

Food

The food industry is using nanomaterials in both the packaging and agricultural sectors. Clay nanocomposites provide an impenetrable barrier to gases such as oxygen or carbon dioxide in lightweight bottles, cartons, and packaging films. Silver nanoparticles, embedded in the plastic of storage containers, kill bacteria.

Engineers and chemists use nanotechnology to adapt the texture and flavor of foods. Nanomaterials' greater surface area may improve the "spreadability" of foods such as mayonnaise, for instance.

Nanotech engineers have isolated and studied the way our taste buds perceive flavor. By targeting individual cells on a taste bud, nanomaterials can enhance the sweetness or saltiness of a particular food. A chemical nicknamed "bitter blocker," for instance, can trick the tongue into not tasting the naturally bitter taste of many foods.



Electronics

Nanotechnology has revolutionized the realm of electronics. It provides faster and more portable systems that can manage and store larger and larger amounts of data.

Nanotech has improved display screens on electronic devices. This involves reducing power consumption while decreasing the weight and thickness of the screens.

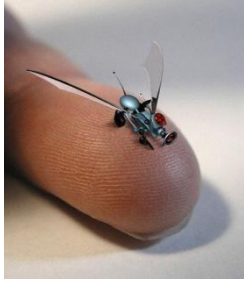
Nanotechnology has allowed glass to be more consumer-friendly. One glass uses nanomaterials to clean itself, for example. As ultraviolet light hits the glass, nanoparticles become energized and begin to break down and loosen organic molecules—dirt—on the glass. Rain cleanly washes the dirt away. Similar technology could be applied to touch-screen devices to resist sweat.

Nanomedicine

Nanotechnology can help medical tools and procedures be more personalized, portable, cheaper, safer, and easier to administer. Silver nanoparticles incorporated into bandages, for example, smother and kill harmful microbes. This can be especially useful in healing burns.

Nanotech is also furthering advances in disease treatments. Researchers are developing ways to use nanoparticles to deliver medications directly to specific cells. This is especially promising for the treatment of cancer, because chemotherapy and radiation treatments can damage healthy as well as diseased tissue.

Dendrimers, nanomaterials with multiple branches, may improve the speed and efficiency of drug delivery. Researchers have experimented with dendrimers that deliver drugs that slow the spread of cerebral palsy in rabbits, for example.



Nanobots

What are nanobots?

Nanobots à la Michael Crichton's *Prey* and other science fiction contraptions of nanoscale robots don't exist (yet).

Not to be confused with these fictional nanorobots, for medical nanotechnology researchers a nanorobot, or nanobot, is a popular term for molecules with a unique property that enables them to be programmed to carry out a specific task. These nanobots are a reality and are being actively researched and developed.

An ever-increasing number of research groups are exploiting programmable self-assembly properties of nucleic acids in creating rationally designed nanoshapes and nanomachines for many different uses. That's why one of the most actively researched areas of nanorobotics today involves DNA assembly, particularly a technique called DNA origami.

Nanorobotic manipulation technologies, including the assembly of nanometer-sized parts, the manipulation of biological cells or molecules, and the types of robots used to perform these tasks also form a component of nanorobotics.

For instance, researchers have translated the autonomous movement trajectories of nanomotors into controlled surface features that brings a twist to conventional static optical fabrication systems, which establishes an early stage approach for a nanorobotics platform for nanomanufacturing.

Why is nanotechnology important?

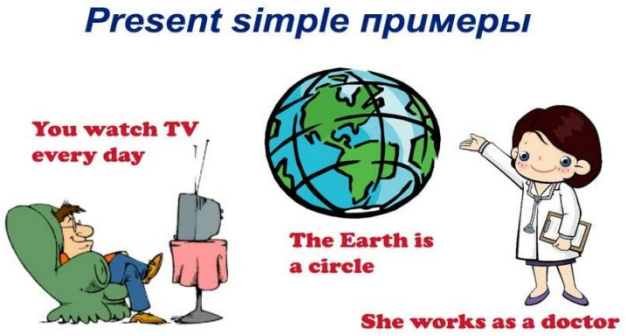
Nanotechnology improves existing industrial processes, materials and applications by scaling them down to the nanoscale in order to ultimately fully exploit the unique quantum and surface phenomena that matter exhibits at the nanoscale. This trend is driven by companies' ongoing quest to improve existing products by creating smaller components and better performance materials, all at a lower cost.

A prime example of an industry where nanoscale manufacturing technologies are employed on a large scale and throughout is the semiconductor industry where device structures have reached the single nanometers scale. Your smartphone, smartwatch or tablet all are containing billions of transistors on a computer chip the size of a finger nail.

Grammar

1. Present Simple

1. We use the present simple to talk about things **in general.**
   We use it to say that something happens all the time or repeatedly, or that something is true in general:
   - Nurses look after patients in hospitals.



2. We say: I work *but* he work**s**
   you go *but* it go**es**
   they teach *but* my sister teach**es**

3. We use **do/does** to make questions and negative sentences:
   - I come from Canada. Where do you come from?
   - I don't go away very often.
   - What does this word mean? (not What means this word?)
   - Rice doesn't grow in cold climates.

4. We use the present simple to say **how often** we do things:
   - I get up at 8 o'clock every morning.
   - How often do you go to the dentist?

2. Phrasal verbs

1. We often use verbs with: in out on off up down away back by through about along over forward round or around.

   So you can say: look out / get on / take off / run away etc. **These are phrasal verbs**.

2. We often use on/off/out etc. with **verbs of movement**.

   For example: get on/ drive off/ come back/ turn round/: The bus was full. We couldn't get on.

3. Often the second word (on/off/out etc.) gives **a special meaning** to the verb.

   For example: break down/ find out/ take off/ give up/ get on/ get by.

   - Sorry I'm late. The car broke down. (= the engine stopped working) I never found out who sent me the flowers. (= I never discovered)

4. Sometimes **a phrasal verb is followed by a preposition**.

   For example: the phrasal verbs look up, run away, keep up, look forward are used with the prepositions at, from, with, to:

   - We looked up at the plane as it flew above us. Why did you run away from me?

5. Sometimes a phrasal verb has **an object**.

   For example: I turned on the light. (the light is the object)

   Usually there are two possible positions for the object. You can say: I turned on the light or I turned the light on.

   But if **the object is a pronoun** (it/them/me/him etc.), only one position is possible: I turned it on. (not I turned on it)