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Review

# Nanobotics

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**Abstract:** Nanobotics (or Nanorobotics) is a field of emerging technology that deals with the creation of robots whose components are typically the size of a molecule or nanometer ($10^{-9}$ meters). More specifically, nanorobotics refers to nanotechnology, an engineering discipline that designs and builds nanorobots that have movement, processing and transmission characteristics, program execution, etc. Nanomachines are largely in the research and development phase, although some primitive and nanomotor molecular machines have already been tested. One example is a sensor with a switch of about 1.5 nanometers, capable of counting specific molecules in a chemical sample. The first useful applications of nanomachines could take place in the field of medical technology, where they could be used to identify and kill cancer cells. Another potential application is the detection of toxic chemicals as well as the measurement of their concentrations in the environment. Rice University has demonstrated a nano auto (nano car) developed through a chemical process, including Buckminsterfullerene for wheels. It is driven by controlling the temperature of the environment and by positioning a tunnel-effect microscope. Another definition describes nanobot as a machine capable of accurately interacting with nanoscale objects, or the ability to manipulate objects at this obvious scale. The vast majority of nanorobots are able to create copies/duplicates, that is to reproduce, these being called replicators.

**Keywords:** Robots, Mechatronic Systems, Structure, Machines, Kinematics, Dynamics, Synthesis, Automation, Nanobotics, Nanorobotics

## Introduction

Nanobotics (or Nanorobotics) is a field of emerging technology that deals with the creation of robots whose components are typically the size of a molecule or nanometer ($10^{-9}$ meters). More specifically, nanorobotics refers to nanotechnology, an engineering discipline that designs and builds nanorobots that have movement, processing and transmission characteristics, program execution, etc.

Nanomachines are largely in the research and development phase, although some primitive and nanomotor molecular machines have already been tested. One example is a sensor with a switch of about 1.5 nanometers, capable of counting specific molecules in a chemical sample. The first useful applications of nanomachines could take place in the field of medical technology, where they could be used to identify and kill cancer cells. Another potential application is the detection of toxic chemicals as well as the measurement of their concentrations in the environment. Rice University has demonstrated a nano auto (nano car) developed through a chemical process, including Buckminsterfullerene for wheels. It is driven by controlling the temperature of the environment and by positioning a tunnel-effect microscope.

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Nanotechnologies represent engineering on a very small scale. They can be applied in many areas, such as health and medicine, information and communications technology, energy and the environment. Nanotechnologies work on the nanoscale - the scale of individual molecules.

Nanotechnologies are very likely to be used on a very large scale. Some predict the emergence of infinitely small computer processors or tiny devices to detect and fix damaged arteries in the human body. Nanotechnologies could generate alternative energy, extend our lives and improve many existing technologies and they are already

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making their appearance. There are already over 1,000 products on the market that use nanomaterials.

A nanometer represents a billionth ($10^{-9}$) of a meter, that is, 0.000 000 001 meters or a millionth of a millimeter. In other words: A nanometer is smaller than a human just as an apple is smaller than the planet Earth.

Nanotechnologies manage materials with nanometer scale sizes, approximately between 1 and 100 nm. This scale is called the nanoscale.

Materials we know at the nanoscale may have new properties. For example, an aluminum foil is a convenient way to keep the sandwiches fresh until noon. But if you take that aluminum foil and tear it into smaller pieces, when they become very, very small (nanometric), something special happens - they become extremely reactive. Even explosive! This makes aluminum nanoparticles excellent for insertion into rocket fuel, but it's probably something you do not want your lunch to come in contact with!

Many living beings use a phenomenon that depends on structures with nanometric dimensions. So a gecko licking on the ceiling, water-repellent leaves, butterfly vivid colors and resistant and flexible materials such as spider webs all use natural nanotechnologies.

In addition to the nanoparticles produced by living beings, some are created by natural phenomena such as erosion and volcanic eruptions. They are also produced as a result of some types of chemical reactions, especially combustion.

We also know that people have already been exposed to some forms of nanoparticles existing in some consumer goods. For example, mineral titanium dioxide - used as a bleach in toothpaste and food colorants - contains a nanoparticle fraction. These are not introduced later but are part of the natural mineral composition, in the form of sand grains of different sizes.

Although scientists have researched nanoscale matter for many years in physics and chemistry, atoms and molecules could be viewed and manipulated directly with the invention of a new generation of microscopes in the 1980s in the IBM laboratory in Switzerland. This has paved the way for systematic investigation of nanomaterials and the realization that their exceptional properties could be used to create innovative materials and devices. Frequently, nanomaterials observed in nature are used as inspiration for designing some innovative ones! That is why many researchers believe that nanoscience is not a revolution, but rather an evolution of traditional scientific disciplines, but nanotechnologies can have some revolutionary implications for our society in terms of applications or tools whose realization may make it easier (Rulkov *et al*., 2016; Agarwala, 2016; Babayemi, 2016; Gusti and Semin, 2016; Mohamed *et al*., 2016; Wessels and Raad, 2016; Maraveas *et al*., 2015; Khalil, 2015; Rhode-Barbarigos *et al*., 2015; Takeuchi *et al*., 2015; Li *et al*., 2015; Vernardos and Gantes, 2015; Bourahla and Blakeborough, 2015; Stavridou *et al*., 2015; Ong *et al*., 2015; Dixit and Pal, 2015; Rajput *et al*., 2016; Rea and Ottaviano, 2016; Zurfi and Zhang, 2016 a-b; Zheng and Li, 2016; Buonomano *et al*., 2016 a-b; Faizal *et al*., 2016; Cataldo, 2006; Ascione *et al*., 2016; Elmeddahi *et al*., 2016; Calise *et al*., 2016; Morse *et al*., 2016; Abouobaida, 2016; Rohit and Dixit, 2016; Kazakov *et al*., 2016; Alwetaishi, 2016; Riccio *et al*., 2016 a-b; Iqbal, 2016; Hasan and El-Naas, 2016; Al-Hasan and Al-Ghamdi, 2016; Jiang *et al*., 2016; Sepúlveda, 2016; Martins *et al*., 2016; Pisello *et al*., 2016; Jarahi, 2016; Mondal *et al*., 2016; Mansour, 2016; Al Qadi *et al*., 2016b; Campo *et al*., 2016; Samantaray *et al*., 2016; Malomar *et al*., 2016; Rich and Badar, 2016; Hirun, 2016; Bucinell, 2016; Nabilou, 2016b; Barone *et al*., 2016; Chisari and Bedon, 2016; Bedon and Louter, 2016; Santos and Bedon, 2016; Minghini *et al*., 2016; Bedon, 2016; Jafari *et al*., 2016; Chiozzi *et al*., 2016; Orlando and Benvenuti, 2016; Wang and Yagi, 2016; Obaiys *et al*., 2016; Ahmed *et al*., 2016; Jauhari *et al*., 2016; Syahrullah and Sinaga, 2016; Shanmugam, 2016; Jaber and Bicker, 2016; Wang *et al*., 2016; Moubarek and Gharsallah, 2016; Amani, 2016; Shruti, 2016; Pérez-de León *et al*., 2016; Mohseni and Tsavdaridis, 2016; Abu-Lebdeh *et al*., 2016; Serebrennikov *et al*., 2016; Budak *et al*., 2016; Augustine *et al*., 2016; Jarahi and Seifilaleh, 2016; Nabilou, 2016a; You *et al*., 2016; AL Qadi *et al*., 2016a; Rama *et al*., 2016; Sallami *et al*., 2016; Huang *et al*., 2016; Ali *et al*., 2016; Kamble and Kumar, 2016; Saikia and Karak, 2016; Zeferino *et al*., 2016; Pravettoni *et al*., 2016; Bedon and Amadio, 2016; Chen and Xu, 2016; Mavukkandy *et al*., 2016; Gruener, 2006; Yeargin *et al*., 2016; Madani and Dababneh, 2016; Alhasanat *et al*., 2016; Elliott *et al*., 2016; Suarez *et al*., 2016; Kuli *et al*., 2016; Waters *et al*., 2016; Montgomery *et al*., 2016; Lamarre *et al*., 2016; Daud *et al*., 2008; Taher *et al*., 2008; Zulkifli *et al*., 2008; Pourmahmoud, 2008; Pannirselvam *et al*., 2008; Ng *et al*., 2008; El-Tous, 2008; Akhesmeh *et al*., 2008; Nachiengtai *et al*., 2008; Moezi *et al*., 2008; Boucetta, 2008; Darabi *et al*., 2008; Semin and Bakar, 2008; Al-Abbas, 2009; Abdullah *et al*., 2009; Abu-Ein, 2009; Opafunso *et al*., 2009; Semin *et al*., 2009 a-c; Zulkifli *et al*., 2009; Marzuki *et al*., 2015; Bier and Mostafavi, 2015; Momta *et al*., 2015; Farokhi and Gordini, 2015; Khalifa *et al*., 2015; Yang and Lin, 2015; Chang *et al*., 2015; Demetriou *et al*., 2015; Rajupillai *et al*., 2015; Sylvester *et al*., 2015; Ab-Rahman *et al*., 2009; Abdullah and Halim, 2009; Zotos and Costopoulos, 2009; Feraga *et al*., 2009; Bakar *et al*., 2009; Cardu *et al*., 2009; Bolonkin, 2009 a-b; Nandhakumar *et al*., 2009; Odeh *et al*., 2009; Lubis *et al*., 2009; Fathallah and Bakar, 2009; Marghany and Hashim, 2009; Kwon *et al*., 2010; Aly and Abuelnasr, 2010; Farahani *et al*., 2010; Ahmed *et al*.,

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## Materials and Methods

In the last decades, our lives have changed radically due to the use of electronic devices. Think about how cell phones have evolved over the last 20 years. Nanotechnologies have played an important role in producing smaller, more efficient and multifunctional devices. In the future, our lives could change through many technological innovations, such as.

The introduction into the circulatory system of drugs that can be activated and controlled from the outside of the human body; they could collect data and send them to the doctor to modify treatment (theranostics).

Nano-sized devices for transporting drugs and targeting cancer cells.

Skin tattoos that monitor levels of salts and other metabolites and warn athletes or diabetics.

Shoes or sensory clothing that collects data during training.

Integrated energy collector systems (in textiles, footwear, etc.) to collect solar and mechanical energy to charge electronic devices.

Flexible and transparent solar panels integrated into windows, ceramic tiles, etc., with the high-efficiency conversion of solar energy.

Surfaces and textiles to remove nitrogen oxides and other smog gases from the urban atmosphere.

Smart Food Packages with Vehicle Detection Sensors for Contamination Detection, which are provided with a tracking/communication system to alert the manufacturer and trader.

Any emerging technology may be associated with unknown health risks when it first comes to consumers. Think about, for example, mobile technology: The health risk posed by the use of mobile phones has been questioned after years of using them, even now this risk is not fully understood. Despite this, we use mobile phones on a regular basis. The safety of nanotechnologies has been the focus of attention for many years, being brought to discussion by several civil society organizations, besides the National Scientific Academies that have raised health problems and have called for early action to ensure the responsible development of nanotechnologies. The common desire is for this technology to progress, while ensuring that workers and consumers are not at risk.

What risks exist? Nanotechnologies use nanoscale materials that are extremely small, therefore there is a concern that they could injure people by penetrating protective barriers such as skin, causing damage to the human body. For example, sunscreens containing nanomaterials have been analyzed. However, to date, scientific evidence demonstrates that nanoparticles do not penetrate the skin. In other words, so far, there has been no evidence that consumer goods containing nanomaterials would be harmful to consumers. However, research continues to verify and detect any toxicity of nanoscale materials, especially for products that come in direct contact with the human body.

All products become waste at the end of their life. A question that the citizens and researchers are asking is: Nanomaterials in nanotechnology-based products have harmful effects when they reach the dump? Could these residues interfere with animals and plants and could cause harmful effects? These are complex questions and finding answers takes time. Many kinds of research take place all over the world. Scientists are also analyzing whether there are safety concerns for washing garments containing nanomaterials. Some civil society organizations claim that consumer goods containing nanomaterials should not be marketed until there are clear answers to these questions. Others claim that we have already coexisted with many natural nanoparticles

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from the environment, nature and pollution. Nanoparticles are not a novelty and even if we should do more research on their safety, we should try not to overload the development of this research area.

There are currently no EC specific regulations on nanomaterials. The official position, after numerous revisions and estimates, is that nanomaterials are well controlled by current regulations.

Nanomaterials are treated like any other chemical, a substance that has to comply with a set of regulations to be used in consumer goods and industrial processes. However, some civil society organizations call for specific regulation for nanomaterials, on the grounds that nanomaterials have special properties that require special attention. At present, there is no law requiring the inclusion of a specification on the content of nanomaterials, except for cosmetics and foods, which should mention this in the list of ingredients (from 2014) on the labeling of a product.

Richard Phillips FEYNMAN - (Angeles and López-Cajún, 1988) - was one of the twentieth century physicists who exerted significant influence not only in physics but also other areas of human knowledge (in many ways it was an eccentric and a free spirit, a convinced atheist).

It is one of those who has extensively expanded the theory of quantum electrodynamics. He participated in the Manhattan Project and was a member of the Challenger Space Shuttle Disaster Investigation Commission.

In 1959, physicist Richard Phillips Feynman laid the groundwork for what would become more than 20 years of molecular nanotechnology.

He then suggested that atoms could be assembled just like the pieces of a Lego game. Among other things, he had advanced the idea that on this scale it was possible to print all the pages of the Encyclopedia Britannica in the needle of a needle (the first edition was published between 1768 and 1771; in 2012 the publishing house decided to renounce the version on paper support of the encyclopedia. After 244 years since its release, the last published edition was in 2010, in 32 volumes, over 40,000 articles, which sell for $ 1395. The reason for the decision is Wikipedia, which, being free of charge, has practically led to almost total stagnation of sales). That's how he began to make great Wikipedia enemies.

For his entire work on the development of quantum electrodynamics, Feynman was one of the Nobel Prize laureates for Physics in 1965 (alongside Julian Schwinger and Sin-Itiro Tomonaga), receiving the Oersted Medal (1972).

Outside the field of theoretical physics, Richard Feynman is credited with the creation of the revolutionary quantum computer concept as well as his early exploration (quantum electrodynamics, particle theory, Feynman diagram).

In the field of pedagogy and oratory, Richard Feynman was a remarkable teacher, a perfect pedagogue, educating many generations of future professionals, physicists and mathematicians and also popularizing with the same remarkable physical talent and moral and ethical aspects of science.

Physicist Richard Phillips Feynman is the first man who spoke about molecular technologies. It was 1959 and few understood how the British Encyclopedia could write on a needle tip. In 1985, two scientists from England built spheres of 60 carbon atoms that resembled the Dome designed by architect Buckminster Fuller.

They are six times lighter and a hundred times more resistant than the best steel. The buckyballs can be agglomerated in the form of cylinders, called "nanotubes".

From nanotubes are made fibers, which can be included in various materials, which become incredibly resistant.

Ottilia Saxl, executive director of the US Nanotechnology Institute, said.

"The medicines we are doing today are very low due to precautions. When we make an antibiotic for killing bacteria, we must make sure that it does not kill our body's cells. A nanorobot, capable of administering poison to only the bacteria we are targeting, would greatly simplify things. "

How would we be able to swallow a little doctor of all that can travel through the blood to any sick cell of the body?

The nano doctor would be attentive to all: To provide medication, to remove tumors, to analyze and to "put the shoulder" on the reconstruction of tissues accidentally destroyed.

Though it seems to be fiction, these medical robots are able to move within the human body in search of infectious agents or cancer cells for the purpose of destroying them can be done through nanotechnology.

Diseases can be diagnosed and healed before the person feels the first inconvenience (which they would further simplify their treatment). Human organs suffering from wear damage such as the liver, kidneys, the bone system and the brain may be helped to restore the destroyed cells before it is too late, making the long and beautiful life, eliminating the embarrassment of transplanted organs (taken from the dead) that are often not compatible (Harris and Harris, 2009; Drexler, 1991; Bejan, 2013).

## Results and Discussion

We live in times when populations in developed and developing countries are changing. Lifestyle illnesses and the aging population are becoming a standard thing. In this context, nanotechnology achievements help prevent the disease from spreading, enabling early diagnosis and multi-level treatments.

The earlier you discover a disease, such as cancer, the greater the chances of fighting the disease. Nanotechnologies allow a new set of diagnostic devices that can detect very small amounts of certain proteins that are associated with some diseases. Early detection means greater chances of successful treatment and disease control.

Scientists studying materials are currently analyzing how to create an "artificial bone" to generate bone tissue in the human body and to cope with the challenges and limitations imposed by conventional bone implants.

One idea is to use molecules naturally found in the bones and to determine their spontaneous self-organization in a larger structure. Nanofibres are formed, which produces a gel that can be used as an adhesive for bone fractures or to create a kind of scaffold to regenerate other tissues.

What would be the creation of a treatment that could only target cancer cells and would not reach healthy cells? One day, nanotechnology could make it possible. Researchers from Rice University have demonstrated the use of nanoparticles with a diameter of 120 nm, coated with a golden layer, to detect malignant tumors. Nanometric layers can be designed to stop cancer cells by adhering antibodies or peptides to the surface of the nanoscale layer.

Once the nanoscale layers are caught by the cancer cells, the latter can be selectively removed using an external infrared laser.

Imagine taking an analgesic pill that is lower and nine times more effective. The use of nanocrystalline drugs makes them easier to absorb by the body.

Several types of nanomaterials, such as lipid or polymeric nanocapsules, are already used in medicines available on the market. Like any other medicine, those containing nanomaterials need to undergo a long and strict regulatory process before they can be marketed, including several clinical trials.

However, some argue that the use of nanomaterials in medicine is quite new, that there are some uncertainties about the way nanomaterials degrade in the body and that they could trigger unwanted side effects in the long run. These critics claim that nanomaterials should be regulated by a special legislative framework when used for medicinal treatment.

The good news is that carbon nanotubes perform extremely well in certain areas. One can say that electronics would be the best candidate (Fig. 1). Companies like IBM see carbon nanotubes as the main element of the next generation of computers.

There is also the possibility of using carbon nanotubes in battery-related technologies and this will lead to the development of more autonomous batteries that could be used in portable electronic equipment and we could have batteries to charge and download faster. The former could be used in electric cars, which would load much faster and rapid unloading could be used to accelerate faster.

Nanomaterials present innovative strategies for drug administration. There is probably not a machine that will administer the drug in a certain way, but the nanomaterial will have a drug release mechanism that can be triggered when it is needed. It is a matter of semantics if we define this nanomaterial as a nanobot.

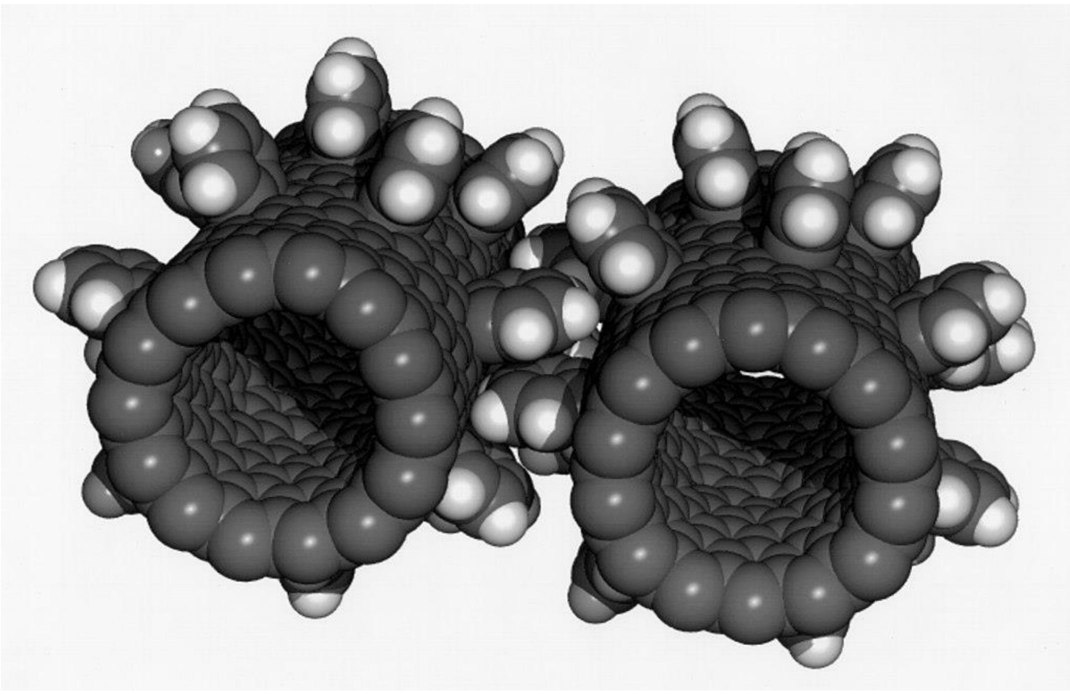

**Fig. 1:** Nanotube based on molecular-weight tools

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For the time being, there is not a single working method for working with atoms, each scientist inventing his own nanotechnology, at present scientists estimate that every day at least one new nanotechnology occurs.

For example, some methods involve changing the quality of some materials using nanotubes. Nanotubes are made of spheres made of 60 carbon atoms, called buckminsterfullerene or, more simply, buckyballs. Materials containing bucky spheres are six times lighter and one hundred times more resistant than steel. To isolate cancer cells, researchers at the University of Michigan have developed a method that uses certain "pieces of DNA molecules" (portions called dendrimers) as "transport means".

Carbon fiber wall paints and nano-sized carbon black particles act as a screen against 99% of high-frequency electromagnetic waves. They can also act as a shield against electromagnetic field interference in measurement labs and in computer centers.

Self-repairing paints will repair small scratches themselves without external intervention. Piezoelectric paints will look fatigue the materials in real time, for example at bridges, thus avoiding destroying the bridge.

Contaminants in wastewater could be removed using nanotechnologies.

Presence of contaminants such as Natural Organic substances (NOM) and small amounts of organic substances that accumulate in the body create great problems in water purification.

Coagulation/flocculation and chlorination technology are the most widely used removal technology contaminants. However, this technology can not completely remove all contaminants. In addition, aluminum exposure is suspected to play a role in triggering Alzheimer's disease.

Researchers from Singapore have been able to obtain a robust nanofibre titanium dioxide membrane that will have great potential in the process of water purification. This membrane plays a double role. It acts both as a filter membrane and photocatalyst. In the presence of UV light, titanium dioxide nanofibres produce a strong oxidizing effect. The material can also be used in sunlight. The efficiency of the membrane to remove humic acids and organic substances in water is about 57-60% in the absence of UV light and 94-100% in the presence of UV light. Producing efficient, low-cost filtering membranes will reduce the cost of drinking water production (Harris and Harris, 2009; Drexler, 1991; Bejan, 2013).

The potential applications of nanotechnologies in the agri-food sector are improving the mechanical and taste properties of foods and changing nutritional value. They can also be used in food packaging, for example, to provide better protection (e.g., nano-margarine) or to detect the degree of product crime.

However, in addition to the many advantages of nano-ingredients, there may be risks to both consumers and workers in these industries, many of which are still unknown to scientists.

Currently, no study has been able to demonstrate the obvious presence of risks, but the level of knowledge in this area is very low. For example, researchers have not yet been able to find answers to many questions about the effect of nanomaterials on health: What happens in the digestive system? Due to smaller sizes than a virus, nanomaterials can enter the body through ways other than those known for other chemicals. Thus, they can pass the cell membrane barrier and produce unexpected and unwanted effects.

Within the EU, only 2 additives are authorized as nano-authorized ingredients

E 551 Silicone Dioxide - the anti-caking agent, commonly used in powdered food, sugar, salt, spices, rice ...

E 174 (nano-orange) - a colorant that can be used in Mentos, M Ms, etc.

All manufacturers who use these ingredients in the form of nano are required under regulation 1169/2011 to clearly indicate their presence

### *Example of Tagging*

Ingredients: Salt, anti-agglomeration: E 551 (nano).

Finally, we can say that manufactured nanomaterials can bring important benefits in advancing the development of food science, but still require in-depth studies on the effects on consumers. Their use must be carried out with great care and with impeccable traceability.

## Conclusion

Nanotechnology is a collective term for technological developments at a nanoscale. In broad terms, nanotechnology is any technology whose finite result is nanometric: Fine particles, chemical synthesis, advanced microlithography and so on. In a narrow sense, nanotechnology is any technology that relies on the ability to build complex structures while respecting atomic specifications using mechanical synthesis. Nanometric structures are not only very small, reaching even to the atomic scale, but they possess some totally distinct and unexpected properties, compared to the same substance taken at the macroscopic level.

In 2004, global investment in nanotechnology development nearly doubled compared to 2003 and reached $ 10 billion. The share of private donors - corporations and funds - amounted to approximately $ 6.6 billion in investment, government agencies' share of about 3.3 billion dollars. World leaders in total investments in this area have become Japan and the United States. Japan has increased the cost of developing new nanotechnologies by 126% compared to 2003 (total investment was $ 4 billion), the US - by 122% ($ 3.4 billion). The volume of the global nanomaterial market in 2001 was $ 555 million and in 2005 it was over $ 900 million.

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3-Contract research. GR 69/10.05.2007: NURC in 2762; theme 8: Dynamic analysis of mechanisms and manipulators with bars and gears.

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## Ethics

This article is original and contains unpublished material. Authors declare that are not ethical issues and no conflict of interest that may arise after the publication of this manuscript.

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