Chapter 7

Our Dwarf World: Nanotechnology

Hilal Kara[1]

Hülya Çelik[2]

Abstract

Nanotechnology, which is the important technology of the 21st century, is the development and production of functional materials, tools and systems in these dimensions by understanding physical, chemical and biological events at the nanometer scale. It also opens new horizons in information, communication and science and technology by evaluating nanotechnology and nano-scale events that will shape the future and developing and applying similar ones. Nanotechnology is the technology of the information age. This technology has the power to revolutionize disease detection and treatment, environmental monitoring and protection, energy production and storage, crop production and food quality improvement, and the construction of complex structures. Nanotechnological research and studies; water treatment systems, energy systems, physical remediation, nano-medical, nano-health, legal and environmental applications, engineering, biology, chemistry, physics, computer programming, materials science and communication. Today, while nanotechnology creates many new working areas, its products are entering our daily lives with increasing speed. In this study, the application areas of nanotechnology, which has an important place in our lives, are presented.

1. INTRODUCTION

Nano means one billionth of a measure and is used in the Greek meanings small, dwarf. Nanotechnology refers to the technological products realized at the nanoscale and covers all the technology at the nona scale [1]. The first use of nanotechnology in history is the presence of nano-sized particles

1 Rabia Hatun Girls Anatolian Imam Hatip High School, Erzurum, ORCID: 0000-0002-7837-2272, hilalkara.1197@gmail.com

2 Ağrı Ibrahim Cecen University, Faculty of Pharmacy Department of Pharmaceutical Technology Departmen 03200 Ağrı/Turkey, ORCID:0000-0003-0805-0523, hycelik@agri.edu.tr

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in the glass, giving a magnificent view when light is passed through the Lycurgus Cup, which was made in Ancient Rome in the fourth century [2]. The concept of nanotechnology was first introduced by Richard Feynman at a conference in 1959 with a speech entitled "There is plenty of room at the below" [3]. Feynmann said that the ability to manufacture products at atomic and molecular size will pave the way for many new discoveries, and said that the 24-volume Encyclopedia Brittanica can be fit on a pin head, better electron microscopy, biological properties with desired properties. Structures, smaller and more functional computers and thousands of discoveries could be made [4].

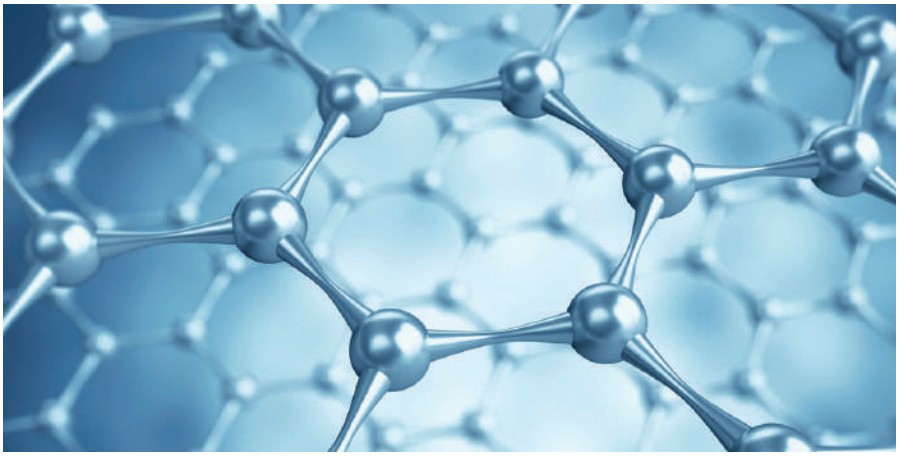

Figure 1. Nanotechnology [5].

Matter consists of atoms and different arrangement of atoms determines a substance. It is possible to obtain products with new properties by changing the atomic arrangement [6]. When nano-dimensions are reached, matter acquires very different physical, chemical and biological properties than macro-dimensions.

In nanotechnology, the desired product can be obtained by taking atoms and molecules one by one and redesigning them. Obtaining the substance in nano size has paved the way for efficient fuel use, drug discovery, and production of lighter and more durable materials [7]. For example, carbon nanotubes are very small in size, have high durability and flexibility. Because of these properties, they are used in spacecraft, television screens and solar cells. Since its chemical activity is low in medicine, it is anticipated to be used as a drug that can be transported to the desired tissue of the body. There are studies on tissue repair and its use in cancer treatment [8]. Nano-

sized carriers make it possible to overcome the difficulties in the treatment of diseases with the formulation of new drugs against infectious diseases. In addition, nanocarriers can be used to produce vaccines against infectious diseases [9]. One of the greatest features of nanotechnology will be in the development of new and effective medical treatments [10]. Nanoscale magnetic resonance imaging shows that nanotechnology can be applied in disease diagnosis. Considering the interactions of individual molecules and molecular groups in nanoscale materials is very important in terms of molecular structure control [11].

It is stated that in the future, thanks to nanotechnology, supercomputers can be looked at under the microscope, there will be nanorobots that find and heal the diseased tissue in the human body and perform surgery, the capacity of the human brain can be strengthened with additional nanomemories, and factories will pollute the environment much less thanks to nanoparticles that prevent pollution [12].

NANOTECHNOLOGY IN OUR LIFE

It is thought that the processing power and capacity of electronic devices and quantum computers obtained at nanometer scales with nanotechnology will increase several times. Construction materials obtained in atomic and molecular dimensions provide the emergence of stronger and lighter materials. These materials will enable revolutionary innovations in the construction industry with unmatched durability and low defect levels. Aviation and space vehicles are very costly technologies. The weight of the materials used in the production of these vehicles is the most important factor in increasing the cost. The fact that both lighter and more durable and flexible materials can be produced with nano technology reduces the cost in this sector. With the use of nanotechnology composites, it will be possible to establish environmentally friendly transportation systems [13].

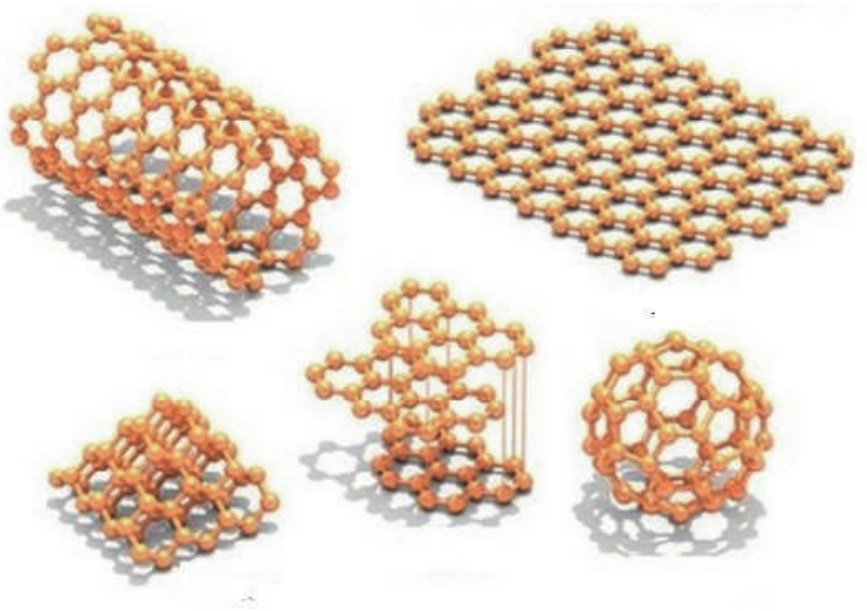

Figure 2. Different arrangement of carbon atoms [14].

Aerospace and space vehicles are very costly technologies. The weight of the materials used in the production of these vehicles is the most important factor in increasing the cost. The ability to produce both lighter and more durable and flexible materials with nano technology reduces the cost in this sector.With the use of nanotechnology composites, it will be possible to establish environmentally friendly transportation systems [13]. Advances in nanotechnology also provide opportunities for the development of healthier foods. [15].

Figure 3. Nano Food and Nano Food Usage Areas [16].

Studies are carried out that will provide beneficial contributions to the reduction of carbon dioxide in cheap and abundant clean water and environmental pollution with nanotechnology [17,18]. In open wounds, skin diseases, anti-allergic and antibacterial, Cooling and stress-reducing clothes have been developed that regulate the electrical balance, protect it from the harmful rays of the sun, protect the body's natural moisture balance, absorb and store heat and release it when needed [19].

The socks, which contain millions of silver nanoparticles in their structure, produced with nanotechnology, prevent the formation of bad odor, also have the ability to kill fungi and maintain their antimicrobial effect for a long time. Textile products that change color with external effects such as heat, light, pressure are dirt-proof and wrinkle-free, detect changes in body functions such as pulse, fever and blood pressure, and warn the user, can be produced. Products that protect from microorganisms, treat wounds and give medication, and make people with a pleasant smell feel better have already begun to be produced. Massachusetts Institute of Technology (MIT) is working on developing "super uniforms" using nanotechnology. These uniforms can support fractures, even develop artificial muscles, change color to provide camouflage, expand and contract according to the conditions of the environment. Uniforms with nanosensors will be able to report the body functions, health information and location of the soldier to the center. These products would be 80% lighter than those used today [20].

Figure 4. Nanotechnology and Health [21].

Medicine and Health Sector With nanotechnology, it will be possible to develop many new diagnostic and treatment methods by producing tools that can interact with living organisms. Machines that deliver drugs only to cells, tissues and organs where the disease is present, diagnostic tools that can act within the human body are examples of nano-technology applications in the field of medicine and health sector. The purpose of designing nano-sized drugs; Drugs in nanoparticle sizes have many advantages such as easily passing through the vessels and mixing with the blood, increasing the solubility and bioavailability with increasing surface area, directing the nanocarriers to the desired cell, tissue and organ, and staying in the circulation for a long time by binding to the molecules. Since a nanocarrier can contain both the active ingredient and the imaging agent, the efficacy of the treatment can be observed [22].

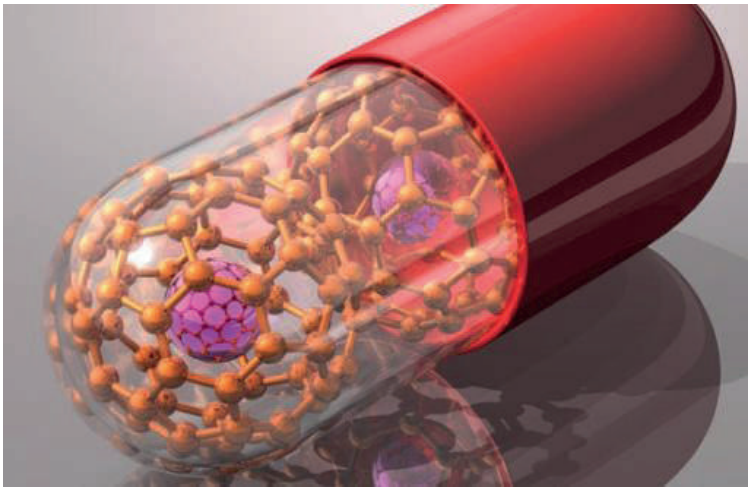

Figure 5. "Health-Friendly" Products of Nanotechnology [23].

With the development of biosensor technologies, it has enabled important developments in the fields of medical imaging, wound healing, pharmacology, microbiology, tissue regeneration, treatment of some chronic diseases, vaccines and genetics. Products produced with nanotechnology; It has been reported that by accelerating the diagnosis of the disease, it provides benefits in early diagnosis, detailed imaging and prevention of infection in cancer. [24].

It is expected to achieve success in cancer treatment at low doses thanks to drug delivery systems realized with nanoparticles [25].

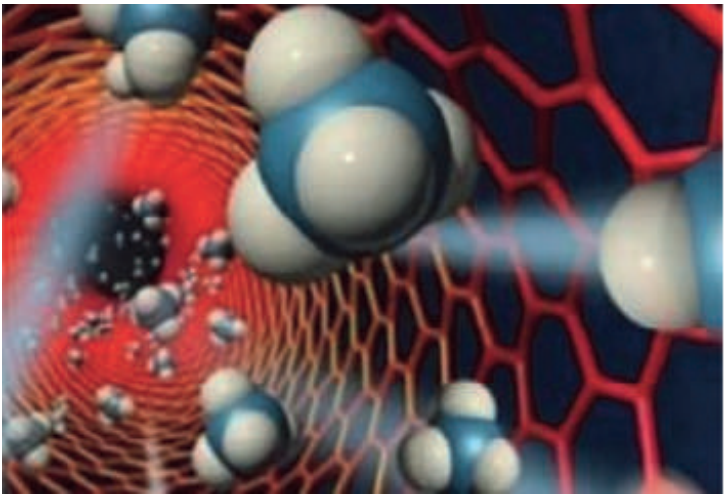

Figure 6. Medical Nanorobots [26].

With drug delivery systems using nanoparticles targeting tumor cells, high success can be achieved in cancer treatment with much lower drug doses.Separation of the brain from the systemic circulation by the blood-brain barrier, preventing the passage of molecules, complicates the treatment of nervous system diseases. Nanocarriers, which enable drug delivery to areas that are difficult to reach in the body, are particularly promising in the treatment of brain tumors [27].

The use of nanoparticles has gained importance as a result of the increase in bacteria resistant to antibiotics and consequently the decrease in the effectiveness of antibiotic treatments [28].

Figure 7. Nanotechnological medicines [29].

Alzheimer's disease is a disease that affects approximately 46 million people worldwide. The presence of the blood-brain barrier in the treatment of Alzheimer's disease makes the treatment of the disease limited. Nanotechnology also provides hope for the treatment of central nervous system diseases such as Alzheimer's disease. Recently, drugs can be transported to the brain at the desired concentration and efficiency with drug delivery systems based on nanotechnology. It is thought that thanks to nanocarrier drugs, the quality of life of patients in the treatment of Alzheimer's disease will increase [30].

2. CONCLUSION AND RESULTS

Nanotechnology, whose name we have heard frequently in recent years, has a great importance in our lives and is encountered in almost every area of life.

These studies at the molecular level, where quantum physics gains functionality in daily life, are used in all areas that benefit humanity. Nanotechnology; materials and manufacturing sector, nano-electrical computer technologies, medicine and health sector, aviation and space research, environment and energy, defense sector, biotechnology, agriculture and food. Advances in nanotechnology are also widely used in the fields of physics, chemistry, biology, computing, mathematics, pharmacy and medicine.

The main purpose of nanotechnology is to make human life easier, from making daily work more efficient to extending lifespan. From the food we eat to the energy sources we use, the vehicles we use, the houses we live in and the clothes we wear, all these applications of nanotechnology that make our lives easier are emerging every day, helping us to build a better and safer life.

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