

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

SOME ISSUES OF THE DEVELOPMENT OF NANOPHYSICS, NANOTECHNOLOGIES AND NANOPRODUCTION

Savurova Shahrizoda Abdumalikovna

Under the National University of Uzbekistan

Nanotechnology Development Center

foundation doctoral student

ABSTRACT

Obviously, the task of training specialists for nanophysics directly relates to higher education. A number of leading universities have already opened departments with a nanotechnology focus, corresponding educational programs are being created, and a staff of teachers is being formed, including leading scientists from various fields of knowledge. This article considers some issues of the development of nanophysics, nanotechnology and nanoproduction.

Keywords: *Nanophysics, nanotechnology, nanoenergy, quantum mechanics, nanometer.*

Introduction

The current state of the domestic economy prioritizes the need for its modernization and transition to an innovative path of development. It is worth noting that the basis for the growth and development of the economy and the transition to a new technological system is the use of the latest achievements of science - nanotechnologies. One of the conditions for the development and implementation of nanophysics is the training of relevant personnel in the field of nanoscience. One of the necessary conditions for the economic growth of any country is the issue of personnel. Based on the information known to us, we can note that at the current stage of development of the field of nanotechnology there is an acute shortage of human resources. One of the possible options for eliminating the shortage of personnel in the field of nanophysics is the creation or establishment of a system for training highly qualified personnel.

The history of modern nanotechnology is associated with centuries-old research efforts of scientists from many countries of the world and has its own long historical trace. Let's consider the most important stages in the history of nanotechnology:

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

◆ The Greek philosopher Democritus, who lived in the 400s, can be considered the “father” of nanotechnology. He was the first to use the word “atom” to describe the smallest particle of matter.

◆ In 1661, the Irish physicist and chemist R. Boyle, one of the founders of the Royal Society of London, in his work “The Skeptical Alchemist”, showed the potential importance of the smallest particles - clusters (“corpuscles”). Criticizing Aristotle’s view of matter, which consisted of four basic principles (earth, fire, water and air), the author proposed that all material objects consist of extremely small particles that are very stable and in various combinations form various substances and things. Later, the ideas of Democritus and Boyle were accepted by the scientific community.

◆ In 1857, the English physicist M. Faraday, the founder of the theory of the electromagnetic field, was the first to create stable colloidal solutions of gold (liquid systems with small particles of the dispersed phase, independent of each other and freely moving). Brownian motion). Later, colloidal solutions began to be widely used to form nanosystems.

◆ In 1861, the English chemist T. Graham discovered the division of substances into colloidal (amorphous) and crystalloid (crystalline) according to the degree of dispersion of the structure.

◆ An example of the first application of nanotechnology is the invention in 1883 by the American inventor, founder of the famous Kodak company D. Eastman of a photographic film with a silver halide emulsion applied to a transparent elastic base: (for example, from cellulose acetate), which, under the influence of light, decomposes with the formation of nanoparticles of pure silver, which are the pixels of the image.

◆ In 1900, the German physicist M. Planck introduced the concept of the quantum of action (Planck's constant) - the rules of quantum theory are important in describing the behavior of nanoparticles.

◆ In 1905, the first scientist to use measurements in nanometers was the famous physicist Albert Einstein, who theoretically proved that the size of a sugar molecule is one nanometer.

◆ In 1924, French physicist Louis de Broglie proposed the idea of the wave properties of matter, thus laying the foundation for quantum mechanics, the study of the motion of microscopic particles. The laws of quantum mechanics have been instrumental in creating nanoscale structures.

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

◆ In 1931, the German physicists M. Knoll and E. Rusko created an electron transmission microscope, which became the prototype of a new generation of devices that allow us to see the world of nanoobjects.

◆ In 1939, R. Siemens released the first industrial electron microscope with a resolution of ~10 nm.

◆ In 1959, the American physicist, Nobel Prize laureate R. Feynman, in his famous lecture at the California Institute of Technology, outlined his ideas on controlling the structure of matter at the atomic level. The development of methods at the atomic level solved many problems in nanophysics. This lecture, in a sense, became a starting point for nano-research. Many of the promising ideas expressed by R. Feynman (about engraving lines several atoms wide with the help of electron beams, using individual atoms to create new small structures, creating electrical circuits on the nanometer scale, using nanostructures in biological systems) have already been implemented today.

◆ In 1971, Bell and IBM produced the first semiconductor films of monoatomic thickness - quantum dots, which marked the beginning of the era of "practical" nanotechnology.

◆ In 1974, the term "nanotechnology" was first proposed by the Japanese physicist N. Taniguchi in his report "On the Basic Concepts of Nanotechnology" at an international conference. This term was used to describe the ultra-fine processing of materials with nanometer accuracy.

◆ In 1981, IBM employees, German physicists G. Binnig and G. Rohrer, created the scanning tunneling microscope (Nobel Prize 1986) - a device that allowed obtaining a three-dimensional image of the size of individual atoms and the structure of an electrically conductive material.

◆ In 1985, a team of scientists consisting of G. Croto (England), R. Curl and R. Smalley (USA) discovered a new allotropic form of carbon in nature - fullerene - and studied its properties (Nobel Prize 1996). The possibility of the existence of highly symmetrical carbon molecules with a spherical structure was predicted by Japanese scientists in 1970. In 1973, Russian scientists D.A. Bochvar and E.G. Galperin performed theoretical quantum chemical calculations to prove the stability of such molecules.

◆ In 1986, a scanning atomic force microscope was created (authors - G. Binnig, K. Quatt, K. Gerber, IBM employees, Nobel Prize 1992), which, unlike the

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

scanning tunneling microscope, made it possible to study the internal structure of the atom. Later, the internal structure of superconductors, as well as any materials, including organic molecules, biological objects, etc., was studied.

◆ In 1987, a single-electron transistor was created by American physicists T. Fulton and G. Dolan. French physicist J.M. Len introduced the concepts of "self-organization" and "self-assembly", which became key concepts in the design of nano-objects.

◆ In 1988-1989, two independent groups of scientists led by A. Fert and P. Grunberg discovered the phenomenon of giant magnetoresistance. This effect is manifested in a significant decrease in the electrical resistance of thin films of alternating ferromagnetic layers under the influence of an external magnetic field. The use of this effect allows recording data on hard disks with atomic data density (Nobel Prize 2007).

◆ 1989 The first practical achievement of nanotechnology was demonstrated: using a scanning tunneling microscope manufactured by IBM, American researchers D. Eigler and E. Schweizer moved a three-letter company logo ("IBM") consisting of 35 xenon atoms across the surface of a nickel single crystal.

◆ In 1990, a team of scientists led by V. Kretschmer (Germany) and D. Hoffman (USA) created an effective technology for synthesizing fullerenes, which contributed to the intensive study of their properties and the identification of promising areas of their application.

◆ In 1991, the Japanese physicist S. Iijima discovered a new form of carbon clusters - carbon nanotubes, which exhibited a number of unique properties and laid the foundation for revolutionary changes in materials science and electronics. After that, the state program for the development of nanotechnologies at the scale of atoms and molecules - the "Atomic Technology" project - began to be implemented in Japan.

◆ In 1993, the first nanotechnology laboratory was established in the USA.

◆ In 1994, a laser based on self-assembled quantum dots was first demonstrated by D. Bimberg (Germany).

◆ 1998 Dutch physicist S. Dekker created the first nanotransistor based on nanotubes.

◆ 2000 The United States launched a large-scale research program in the field of nanotechnology called the National Nanotechnology Initiative (NNI). German

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

physicist R. Magerle proposed nanotomography technology - a three-dimensional image of the internal structure of a substance with a thickness of 100 nm was created.

♦ 2002 F. Kukes and S. Williams, employees of the Packard Research Center (USA), created a technology for creating microcircuits based on complex nanowires, implemented at the molecular level. S. Dekker developed the mechanism of binding of carbon nanotubes to DNA.

♦ In 2004, scientists A. Geim and K. Novoselov at the University of Manchester (UK) created graphene - a graphite material with a thickness of one atom, which later became a material that replaced silicon in integrated circuits (Nobel Prize 2010).

♦ In 2007, Intel (USA) began producing processors containing the smallest structural element with a size of 45 nm. Employees of the Georgia Institute of Technology (USA) developed a scanning lithography technology with a size of 12 nm. The above research, discoveries and inventions gave a powerful impetus to the widespread use of nanotechnologies in industry and the rapid development of practical nanotechnologies began. The first commercial nanomaterials appeared - nanopowders, nanocoatings, bulk nanomaterials, nanochemical and nanobiological preparations; the first electronic devices and sensors for various purposes based on nanotechnologies were created. Many countries of the world have actively participated in research at the level of governments and heads of state on nanotechnology issues, assessing future prospects. Nanostructure laboratories and departments have been established in leading universities and institutes of the world (USA, Germany, Japan, Russia, England, France, Italy, Switzerland, China, Israel, etc.) and are headed by famous scientists. Nanotechnologies are already used in the most important areas of human activity - radio electronics, information technology, energy, transport, biotechnology, medicine and the defense industry. Today, more than 50 countries of the world are engaged in nano research. Eight Nobel Prizes have been awarded for unique research results in this area.

In modern industry, some raw material is used to produce a product, for example, a tree is cut down for furniture and the like. Before this tree is transformed into a useful product, a significant part of it turns into waste. However, nature works much more economically than humans in creating its biosystems - it uses waste-free assembly and self-assembly technology to create complex systems from simple molecules (for example, in protein synthesis), connecting "production" flows or chains to each other

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

in such a way that the "waste" generated in one process serves as raw material for the next process, and as a result, there is no such thing as waste.

Over the past decade, it has become possible to move towards such a "wasteless" way of working and create industrial nanotechnologies - this has shown that a completely different approach to modern industry is possible: instead of processing raw materials "top-down" when creating a product (in other words, cutting, grinding, and removing waste from large blanks to create small parts or finished products), it is possible to assemble parts "bottom-up" from the elementary "bricks" of nature (atoms and molecules) and use the principle of self-assembly, in which there is no such thing as waste.

Of course, the ideas presented here seem like bright slogans or images, but they are an approach to large-scale production, which the laws of physics do not deny. In the future, certain materials, products, or parts of them, will be made from larger raw materials (the "top-down" method will probably be partially preserved), while the rest will be made on the basis of nanotechnologies, in other words, these two principles seem to complement each other for many years to come.

It is known that the structure and properties of atoms depend on the number of nucleons in their nucleus and are governed by the laws of quantum mechanics. The structure of atoms does not change at the will of a person - they can be called the smallest portion of matter. However, the properties of a cluster (or a mixture of several molecules) consisting of several atoms or molecules depend on the number of molecules in it, and this number can be changed by a person at will, and this change, in turn, changes the properties of the cluster (or product). This is what nanotechnologies strive for.

Another good example of the need for nanotechnologies and nanoproducts can be given. We know that man has been creating various tools for himself for many years and is constantly improving them. The dimensions of some of these tools are ≈ 1 m around, for example, hoe, pickaxe, axe, etc. Their dimensions have not changed even for a thousand years. There are such devices that, if their dimensions are reduced, they become even better, they become more economical and faster, and begin to perform their functions more reliably. Transistors can be cited as a vivid example of this. In the second half of the 20th century, the development of electronics and electronic computing technology occurred in parallel with the miniaturization of semiconductor diodes, triodes, microcircuits, and entire processor systems. At that time, the basis for

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

the ideas of reducing the size of objects in the hands of mankind as much as possible, if possible, bringing them closer to the size of atoms and molecules, appeared. Naturally, atoms and molecules serve as the “building material” in the creation of nanosystems, but what about the construction technology? Of course, the most effective technology is the process of self-assembly and self-organization (“self-organization”) of elements. The progress made in the microminiaturization of electronic elements is amazing: for half a century, Moore’s law has been fulfilled - every 1.5-2 years, the number of elements (including transistors) placed on a “chip” has doubled, while their size R has decreased. As a result, the number of elements in microcircuits created today has approached the number of people on Earth ($\approx 6 \cdot 10^9$ people), but these elements are 1 cm^2 placed on the surface. These days, it has been brought down to $R = 100 \text{ nm}$ the size of elements, but getting down to ($\approx 0.1 \text{ nm}$) of atoms will require a lot of work and a lot of time. The rapid development of nanotechnology over the past 10 years can be seen in the increase in funding for programs related to this field, the sharp increase in the number of articles and patents, conferences and specialized journals. In order to implement the achievements of nanotechnology in practice, we must have in-depth knowledge of the structure and properties of nanoobjects and nanomaterials, the fundamental principles and laws of their response to external influences, the technologies for synthesizing and researching nanomaterials, methods for their large-scale production and quality control. For this, first of all, textbooks or monographs are needed that summarize and systematize the fundamental knowledge about the science of nanotechnology. Unfortunately, such literature has not yet been written by our specialists in the Uzbek language. This booklet in your hands is the result of an effort to at least somewhat reduce this literature deficit. The main purpose of the booklet is to familiarize master's and postgraduate students with the laws and principles that form the foundations of the science of nanotechnology and the principles of operation of equipment (microscopes) that allow viewing, studying, constructing and manipulating nanoobjects.

The nanotechnological revolution is increasingly gaining momentum around the world. In the next 10-15 years, this direction will dramatically change the economy, production, science and technology of many countries, and there will be major changes in people's lives. The skillful and effective use of the achievements of new science and technology will become a strategic task for many countries and an advantage over others. Therefore, it is of great importance for each country to find its own orientation

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

and path in this area. Nanotechnology is a new global technological ideology. What can humanity expect from this technology in the future? Some of these questions can be answered today, while others require time and in-depth study. For now, the following conclusions can be drawn:

1. The economies of countries that have mastered nanotechnologies well and are able to establish their production will make a big step forward. There will be major changes in the priorities and structure of production, which means that a new generation of workers, engineers and managers will be needed. Products are changing (refreshing) very quickly, so everyone (both ordinary workers and managers) will have to constantly improve their knowledge. Higher education in the 21st century, therefore, becomes a continuous education, a person continues to receive and improve education throughout the active part of his life without stopping. The new paradigm of higher education puts the technology of obtaining (or acquiring) knowledge in the first place, not what knowledge consists of (in Russian “soderzhaniye”, in English “content”). This technology has received the name E – learning (Electronic learning) in developed countries. In a number of countries, an economy based on knowledge and high technologies has emerged, which is based not on gas, oil and forests, the reserves of which are limited, but on scientific achievements.

Conclusion. There will be major changes in nanoenergy, engines based on new principles will be produced, and as a result, air pollution will be significantly reduced. The objects surrounding us will acquire intellectual properties as a result of the installation of microchips in them. They will be able to adapt to changing conditions and optimally perform their work mode. In other words, clothes will begin to warm the body better, the temperature and lighting in the room will adapt to the wishes of a person, cars will find the optimal route and learn to avoid collisions with other cars. Medicines, diagnostics, treatment will be based on completely new principles, drastic changes will occur in pharmaceuticals and medicine, treatment will become cheaper and more effective, which will significantly extend a person's life, make his life healthier. There will be major changes in military equipment, soldiers' uniforms, and methods of combating terrorism, and life will become safer. The production of self-replicating nanorobots with artificial intelligence will be launched, and the environment, including space, will be mastered by robots. Due to increased productivity, people will have more free time, which they will use for spiritual development, education, sports, and recreation. There will be major changes in human

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

psychology and worldview, and work will be carried out to philosophically analyze these changes and direct them to improving life.

Literature:

1. Komil Muqimov. *Mitti bunyodkorlar yoxud nanotexnologiyalar nima?*, "Kamalak" nashriyoti, Toshkent-2017.

2. K.M.Muqimov, Sh.A.Savurova, Features of studying a nanophysics course in higher educational institutions, "Ta'lim transformatsiyasi" ilmiy-nazariy va metodik jurnal; 2023.

3. K.M.Muqimov, Sh.A.Savurova, Methodological aspects of organizing nanophysics training in higher educational institutions, "**Ta'lim, fan va innovatsiya**" **Ma'naviy-ma'rifiy, ilmiy-uslubiy jurnal**; 2024.

4. Sh.A.Savurova, Олий таълим муассасаларида нанофизика курсини ташкил этишнинг ўзига хос хусусиятлари, "Fizika fanining rivojida iste'dodli yoshlarning o'rnini" Respublika ilmiy-amaliy konferensiya (RIAK-XVII-2024) materiallari to'plami: O'zMU; 2024.

5. K.M.Muqimov, Sh.A.Savurova, Нанофизика курсининг фундаментал билимлари, "PEDAGOGS" international research journal; 2024.

6. K.M.Muqimov, Sh.A.Savurova, Нанотехнологияларларнинг ривожланиш тарихи ва асосий йўналишлари ҳақида айрим масалалар, "O'quvchilarda tabiiy-ilmiy savodxonlikni rivojlantirish va raqamli dunyoni o'rganishlarini tashkil etishning istiqbollari" mavzusidagi ilmiy-amaliy konferensiya materiallari: Surxondaryo viloyati Pedagogik mahorat markazi, Termiz; 2024.

7. K.M.Muqimov, Sh.A.Savurova, Шредингер тенгламаси, квант ҳолатлари ва энергиялари, тўсиқни туннел қилиш, "Ilm-fan taraqqiyoti: ilmiy innovatsion yondashuvlar va strategik tahlillar" mavzusidagi xalqaro ilmiy-amaliy anjuman SAMBHRAM To'plam-1: 2-sho'ba. *aniq va tabiiy fanlarda innovatsion tadqiqotlar (240-244 betlar)*; 2024.

8. Sh.A.Savurova, R.R.Burxonov, Nanotexnologiya rivojlanish bosqichlari, "Ilm-fan taraqqiyoti: ilmiy innovatsion yondashuvlar va strategik tahlillar" mavzusidagi xalqaro ilmiy-amaliy anjuman SAMBHRAM To'plam-2: 1-sho'ba. *it sohasida muammolar, yechimlar va istiqbollar (20-23 betlar)*; 2024.

9. Ш.А.Савурова, Заррача (квант) модданинг табиати: фотонлар, электронлар, атомлар, молекулар, "Journal of Physics and Technology Education" <https://phys->

МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА

Researchbib Impact factor: 13.14/2024

SJIF 2024 = 5.444

Том 3, Выпуск 03, Март

tech.jdpu.uz (Online) “Физика ва технологик таълим” журнали: Жиззах – 2025, Volume 1, Issue 1(20), 2025 25 феврал (66-69- бетлар)

10 Sh.A.Savurova, Kovalent bog‘lanish va kovalent bog‘lanishga qarshi, sof nanofizik effektlar, “Journal of Physics and Technology Education” <https://phys-tech.jdpu.uz> (Online) “Физика ва технологик таълим” журнали: Жиззах – 2025, Volume 1, Issue 1(20), 2025 25 феврал (70-73- бетлар)

11. Suzdalev, I.P. Nanotexnologiyalar: nanoklasterlar, nanostrukturalar va nanomateriallarning fizikasi va kimyosi. M.: KomKniga, 2006.- 592 b.

12. Gusev, A.I. Nanokristalli materiallar. M.: Fizmatlit, 2000. - 224 b.

13. R.A. Andriyevskiy, A.V. Ragulya. Nanostrukturali materiallar. Kiyev: Akademiya, 2005, 185 b.

14. C.Poole Jr., F. Ouyens. Nanatexnologiyalar. Trans. Ingliz tilidan tarj. Yu. I. Golovina. M.: Texnosfera, 2006, 336 b.

15. V.I. Belyavskiy. Yarimo‘tkazgich nanotexnologiyalarsining fizik asoslari. Soros ta’lim jurnali, 1998 yil, № 10, bet. 92-98.

16. Ivanov, V.K. Metall klasterlarning elektron xususiyatlari. Soros ta’lim jurnali - 1999. – № 8. - S. 97.

17. Gusev, A.I. Nanomateriallar, nanostrukturalar, nanotexnologiyalar. A.I. Gusev. - M.: Fizmatlit, 2005. - 416 b.

18. X. Gleyter. Nanostrukturali materiallar: asosiy tushunchalar va mikrostruktura. Acta Materiya. 2000, № 48, 1-29 b.

19. A.V. Yeletskiy. Uglerod nanotubalari va ularning emissiya xossalari. UFN, 2002, 172, №4, 401-438 b.

20. Yu.A. Osipyan, V.V. Fullerenlar zamonaviy texnologiya uchun yangi moddalardir. Metallurgiya, 1997 yil, №1, 2-6 b.

21. G. Binnig, G. Rorer. Skanerli tunnel mikroskopi (fizika bo‘yicha Nobel ma’ruzalari - 1986). UFN, 1988, T. 154, №. 2, p. 261-278 b.

22. V.Ya. Demixovskiy. Kvant quduqlari, iplar, nuqtalar. Bu nima? Soros ta’lim jurnali, 1997, № 5, 80-86 b.