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A.K. Seitkhanova, Candidate of physico-mathematical sciences, PhD
Innovative University of Eurasia (Pavlodar)

A.P. Romanovtcev
Innovative University of Eurasia (Pavlodar)
E-mail: artemronamovcev@mail.ru

***Current state and development trends of nanotechnology
in the Republic of Kazakhstan***

Annotation. *Nanotechnology is a field of fundamental and applied science and technology dealing with a combination of theoretical substantiation, practical methods of research, analysis and synthesis, as well as methods for the production and application of products with a given atomic structure through controlled manipulation of individual atoms and molecules.*

In the Address of the President of the Republic of Kazakhstan to the people of Kazakhstan Strategy "Kazakhstan-2050" New political course of the state, the leader of the nation, N.A. Nazarbayev, defines 10 tasks that Kazakhstan faces, one of which is the transition of Kazakhstan to the third industrial revolution. Nanotechnology is one of the branches of the industrial revolution. In the modern world, over the past few years, there has been a rapid development of nanotechnology. The peculiarity of nanotechnology lies in the possibility of their application in an unlimited sphere; therefore they are the basis for a completely new technological order of the economy. Consequently, its development in the country is regarded as a particularly important sphere of science. Usage of nanotechnology products will save on raw materials and energy consumption, reduce emissions to the atmosphere and, as a result, will contribute to sustainable economic development.

Key words: *nanotechnology, nanoparticle, nanomaterial, synthesis, nanoobject.*

Nanotechnology is a field of fundamental and applied science and technology dealing with a combination of theoretical justification, practical methods of research, analysis and synthesis, as well as methods for the production and application of products with a given atomic structure through controlled manipulation of individual atoms and molecules.

The practical aspect of nanotechnology includes the production of devices and their components necessary for the creation, processing and manipulation of atoms, molecules and nanoparticles. It is implied that it is not necessary for an object to have at least one linear size less than 100 nm it can be macro objects whose atomic structure is controlled with resolution at the level of individual atoms, or containing nano objects. In a broader sense, this term also covers the methods of diagnostics, characterology and research of such objects [1].

Nanotechnologies are qualitatively different from traditional disciplines, because on this scale, the usual macroscopic technologies for handling matter are often inapplicable, and microscopic phenomena that are negligibly weak on the usual scales become much more significant: the properties and interactions of individual atoms and molecules or aggregates of molecules (for example, Van- der-Waals), quantum effects.

Nanotechnology and, in particular, molecular technology is new, very little-studied disciplines. The main discoveries predicted in this area have not yet been made. Nevertheless, the conducted studies already give practical results. The use of advanced scientific achievements in nanotechnology makes it possible to refer it to high technologies [2].

The development of modern electronics is on the way to reducing the size of devices. On the other hand, classical methods of production approach their natural economic and technological barrier when the size of the device decreases slightly, but the economic costs increase exponentially. Nanotechnology is the next logical step in the development of electronics and other high-end industries.

Nanoparticles

The current trend towards miniaturization has shown that the substance can have completely new properties if one takes a very small particle of this substance. Particles with sizes from 1 to 200 nanometers are usually called «nanoparticles». For example, it turned out that nanoparticles of some materials have very good catalytic and adsorption properties. Other materials show surprising optical properties, for example, ultrathin films of organic materials are used for the production of solar cells. Such batteries, although they have a relatively low quantum efficiency, are more cheap and can be mechanically flexible. It is possible to achieve the interaction of artificial nanoparticles with natural objects of nanoscale - proteins, nucleic acids, etc. Thoroughly purified nanoparticles can self-adjust themselves to certain structures. Such a structure contains strictly ordered nanoparticles and also often exhibits unusual properties [4].

Nano-objects are divided into 3 main classes: three-dimensional particles obtained by exploding conductors, plasma synthesis, restoration of thin films, etc.; two-dimensional objects – films obtained by molecular layering, CVD, ALD, ion-layering, etc.; one-dimensional objects are whiskers, these objects are obtained by molecular layering, the introduction of substances into cylindrical micropores, etc. There are also nanocomposites, materials obtained by introducing nanoparticles into any matrix. At the moment, a wide application has been obtained only by the method of microlithography, which allows obtaining on the surface of

matrices flat island objects with a size of 50 nm, it is used in electronics; the CVD and ALD method is mainly used to create micron films. Other methods are mainly used for scientific purposes. In particular, it should be noted the methods of ionic and molecular layering, because with their help it is possible to create real monolayers [5].

What nanotechnologies are capable of.

Here are just some areas in which nanotechnology promises a breakthrough:

– Medicine

Nanosensors will ensure progress in the early diagnosis of diseases. This will increase the chances of recovery. We will be able to defeat cancer and other diseases. Old cancer drugs destroyed not only diseased cells, but also healthy ones. With the help of nanotechnology, the medicine will be delivered directly to the diseased cell.

– Building

Nano-sensors of building structures will monitor their strength, detect any threats to integrity. Objects built using nanotechnology will last five times longer than modern facilities. The houses will be adjusted to the needs of the tenants, providing them with a cool in summer and keeping warm in winter.

– Power engineering

We will depend less on oil and gas. Modern solar panels have an efficiency of about 20 %. With the use of nanotechnology, it can grow 2-3 times. Thin nanofilms on the roof and walls can provide energy to the whole house (if, of course, the sun will be enough).

– Engineering

All the cumbersome technology will be replaced by robots – easily controlled devices. They can create any mechanisms at the level of atoms and molecules. For the production of machines, new nanomaterials will be used that can reduce friction, protect parts from damage, and save energy. This is not all areas in which nanotechnologies can (and will) be used. Scientists believe that the emergence of nanotechnology is the beginning of a new scientific and technological revolution, which will greatly change the world already in the twenty-first century. It is worth, however, to note that nanotechnology does not enter into real practice very quickly. Not many devices (mostly electronics) work «with nano». This is partly due to the high price of nanotechnology and not too high return on nanotechnology products [8].

Prospects for the development of nanotechnology in the Republic of Kazakhstan.

In the Address of the President of the Republic of Kazakhstan, the leader of the nation, to the People of Kazakhstan in Strategy "Kazakhstan-2050" the new political course of the state held N.A. Nazarbayev defines 10 tasks that Kazakhstan faces, one of which is the transition of Kazakhstan to the third industrial revolution.

Nanotechnology is one of the branches of the industrial revolution. In the modern world, over the past few years, there has been a rapid development of nanotechnology. The peculiarity of nanotechnology lies in the possibility of their application in an unlimited sphere; therefore they are the basis for a completely new technological order of the economy. Therefore, its development in the country is regarded as a particularly important sphere of science. Application of nanotechnology products will save on raw materials and energy consumption, reduce emissions to the atmosphere and, as a result, will contribute to sustainable economic development.

And now we will consider the prospects of development of nanotechnology in Kazakhstan science. According to the state programs of science development in the Republic of Kazakhstan for 2007-2012, on the forced industrial and innovative development of the Republic of Kazakhstan for 2010-2014, № 958 dated March 19, 2010 nanotechnology is one of the priority areas. The coordinators of such studies are the Ministry of Education and Science of the Republic of Kazakhstan and the National Academy of Sciences of the Republic of Kazakhstan.

Today, Kazakhstan has sufficient scientific and economic potential for the development of the domestic nanoindustry. Work with nanoobjects began quite a long time ago, including in Kazakhstan. Many areas of research in chemistry and biotechnology are carried out at the molecular level, in fact, occur at the nanoscale. Research is carried out in the field of synthesis of nanoclusters and nanostructures of semiconductor and metal systems. There are developments in the field of nanoscale catalysts, sensory nanostructured materials and hydrocarbon nanostructures [3].

The main field of application of nanotechnology, which assumes a significant return in the short term, is the creation of nanostructured catalysts and pharmaceuticals, components of nanoelectronics and multifunctional materials. In fact, the quality of currently produced products will improve, including nanocomponents. All the beginnings from the field of science on the part of the state give us hope and faith in the future. The future is in the hands of science, so its development means the country's development in the world arena.

In Almaty, on the basis of KazNU al-Farabi, a national nanotechnology laboratory was opened. Here the leading scientists of the country will be able to conduct research and development, train qualified specialists and develop breakthrough projects in this field. Nanotechnology confidently conquers the world. However, what is it, understand a few. Scientists of the laboratory tried to explain everything in an accessible language. Speaking figuratively, with the help of a microscope on an area equal to one-hundredth of a part of the thickness of the hair, several dozen galaxies can be considered. And this allows us to accurately study the properties of any substance at the level of atoms under the influence of external factors [9].

Nanotechnology allows not only to observe the properties of substances, but also to collect crystals of the desired properties from individual atoms, as from the details of the designer.

The next most-demanded professions of the near future are related to nanotechnology.

Nanotechnologies are technologies based on working with molecules and atoms, these are technologies that use the most hidden and valuable properties of a substance. Nanotechnology is a huge sphere that can be divided into three parts: the production of microcircuits, robots in nanoscale, and also engineering at the atomic level. Nanotechnology will be connected with all branches of science.

Already today a breakthrough in this area has allowed the use of fundamentally new materials for the manufacture of sports equipment, transistors, drugs and medical equipment, materials for packaging food, cosmetics and clothing. Nanotechnology has a truly enormous potential. Therefore, it is no coincidence that a whole program for the development of the nanoindustry has been developed in Kazakhstan. The head of state set the task in a short time to create a scientific and technological base in this area and start developing both nanomaterials and nanobiotechnologies. The creation of a national nanotechnology laboratory is only the first step.

Today, 9 engineering laboratories operate in the country's large universities. However, a laboratory of such a scale as the national one is so far the only one. In the near future it is planned to open 4 more similar ones. They will conduct developments in the field of information technology, biotechnology, in the gas and oil industries. Thus, the day when Kazakhstan can boast of its breakthrough projects in the field of nanotechnology is not far off.

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ТҮЙІН

А.К. Сейтханова, Физика-математика ғылымдарының кандидаты, PhD

А.П. Романовцев

Инновациялық Еуразия университеті (Павлодар қ.)

Қазақстан Республикасында нанотехнологияны дамытудың жай-күйі мен перспективалары

Нанотехнология – теориялық негіздемесі, зерттеудің тәжірибелік әдістемесі, талдау және синтездің, сондай-ақ жеке атомдар мен молекулалардың бақыланып манипуляциясы арқылы атом құрылымы бар өнімдерді өндіру және қолдану әдістері жиынтығынан тұратын іргелі және қолданбалы ғылым мен техниканың саласы. Қазақстан Республикасы Президенті Ұлт көшбасшысының Қазақстан халқына Жолдауында – «Қазақстан-2050» мемлекеттің жаңа саяси бағыты Стратегиясында Н.А. Назарбаев алдына 10 мақсатты көздеген, оның бірі – Қазақстанның үшінші индустриалды революцияға көшуі. Нанотехнология – бұл өнеркәсіптік революцияның салаларының бірі. Бүгінгі әлемде, соңғы бірнеше жылда, нанотехнология қарқынды дамуда. Нанотехнологияның ерекшелігі шексіз салада пайдалану мүмкіндігі болып отыр, сондықтан олар экономиканың мүлдем жаңа технологиялық құрылымы үшін негіз бола алады. Сондықтан оның дамуы елдегі ғылымның аса маңызды саласы болып саналады. Нанотехнология өнімдерін пайдалану, шикізат пен энергия тұтынуда үнемдеуге шығарындыларды қысқарту және соның салдары ретінде, тұрақты экономикалық дамуына ықпал ететін болады.

Түйінді сөздер: нанотехнология, нанобөлшек, наноматериалдар, синтез, нанобъект.

РЕЗЮМЕ

А.К. Сейтханова, кандидат физико-математических наук

А.П. Романовцев

Инновационный Евразийский университет (г. Павлодар)

Состояние и перспективы развития нанотехнологий в Республике Казахстан

Нанотехнология – область фундаментальной и прикладной науки и техники, имеющая дело с совокупностью теоретического обоснования, практических методов исследования, анализа и синтеза, а также методов производства и применения продуктов с заданной атомной структурой путём контролируемого манипулирования отдельными атомами и молекулами.

В Послании Президента Республики Казахстан народу Казахстана «Стратегия «Казахстан-2050» – Новый политический курс состоящегося государства», лидер нации Н.А. Назарбаев определяет 10 задач, которые стоят перед Казахстаном, одна из них – переход Казахстана к третьей индустриальной революции. В качестве одной из ветвей индустриальной революции являются нанотехнологии. В современном мире за несколько последних лет происходит стремительное развитие нанотехнологий. Особенность нанотехнологий заключается в возможности их применения в неограниченной сфере, они являются базисом для совершенно нового технологического уклада экономики. Поэтому ее развитие в стране рассматривается как особо важная сфера науки. Применение продукции нанотехнологий позволит сэкономить на сырье и потреблении энергии, сократить выбросы в атмосферу и, как следствие, будут способствовать устойчивому развитию экономики.

Ключевые слова: нанотехнологии, наночастица, наноматериал, синтез, нанообъект.