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NANOTECHNOLOGIES - ACHIEVEMENTS AND PROSPECTS

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Annotation. Achievements, possible prospects for the development of nanotechnology, as well as all possible areas of their application are considered. A comparative analysis of both positive and negative possible consequences in the development of nanotechnology in human life is carried out.

Keywords. Nanotechnology, nanoparticles, graphene, nanosensors, smart dust.

Introduction. Nanotechnologies are innovative and make great strides in the development of the scientific and technological revolution. The practical aspect of nanotechnology involves the production of devices and their components necessary for the creation, processing and manipulation of atoms, molecules and nanoparticles.

The quantum nature of nanotechnological processes makes them very knowledge-intensive and stimulates the development of such applied areas as nanomachines, nanocosmonautics, nanomechanics, the creation and development of such an industry as the production of nanomaterials.

Nanotechnology makes it possible to control particle size and thus improve the properties of materials. The miniaturization of structures leads to the creation of new objects, such as nanotubes, carbon nanoscales, thin films, quantum conductors and matrix elements, laser generators with unique properties.

Main part. Nanotechnologies are a set of processes that make it possible to create substances, materials, devices and technical systems, the functioning of which is determined primarily by their nanostructure [1].

Nanotechnologies have proven to be useful in many areas of modern production, such as the production of computer equipment, the space and aviation industries, and nanomechanics (the production of nanomotors and robots). Nanotechnologies have also become widespread in the field of medicine, agriculture, chemistry, biology and ecology.

Nanoparticles - particles of various substances: larger than an atom and a molecule, but smaller than visible grains. The size of nanoparticles varies from 1 to 100 nanometers; they are about 40-80 thousand times smaller than the thickness of a human hair [2].

Graphene is an example of nanoparticles. Graphene (G) is a two-dimensional allotropic modification of carbon formed by a layer of carbon atoms one atom thick [3].

The chemical structure of G is shown in figure 1.

The material has the following properties:

- great mechanical rigidity;
- flexibility;
- high thermal conductivity;
- melting point above 3000 degrees Celsius.

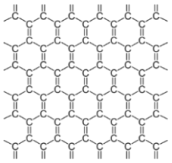

Figure 1 – Chemical structure of graphene

In medical research, G has shown anti-cancer properties. It is assumed that graphene can be effective in a wide range of tumors. The thermoelectric effect will significantly increase the efficiency of semiconductor solar cells using G.

Another example in advances in nanotechnology is nanosensor.

US scientists have developed AI-based nanosensors that allow researchers to track different kinds of biological molecules without disturbing them.

The new innovative technology uses nanotechnology, meta-surfaces, infrared radiation and artificial intelligence (AI).

Meta-surfaces are man-made materials with enhanced light manipulation capabilities at the nanoscale, allowing functions beyond what we see in nature. Here, their precisely engineered meta-atoms, made of gold nanorods, act as amplifiers of light-material interactions, tapping into plasmonic excitations resulting from the collective vibrations of free electrons in metals [4]. When scientists added infrared meta-surfaces to AI, the new sensor began to be used to analyze biological processes and their dynamic interactions.

The next example of advances in nanotechnology is the smart dust.

Smart dust - are self-organizing tiny devices (group robots) that exchange wireless signals and work as a single system [5]. It is assumed that the basic elements of "smart dust" - motes - will eventually be the size of a particle of sand or even dust. Each mote will have to have its own sensors, computing node, communication and power supply subsystems. Grouped together, motes will automatically create very flexible, low power networks. Their applications can range from climate control systems to entertainment devices that interact with other information devices.

Nanotechnologies also have negative properties. For example, molecules of heavy metals or other toxic substances can enter the human body and other living beings. Recent studies have shown that nanoparticles can not only penetrate tissues, but also accumulate in them. Chemically active nanoparticles can form strong bonds with biomolecules (for example, proteins or DNA), damaging them, "turning off" or, conversely, promoting their increased activity.

Another variant of the negative impact is the catalysis of chemical reactions harmful to the body. Even if the "suspected" nanoparticles turn out to be harmless, impurities contained in them, which are very difficult to detect, can have a detrimental effect (impurity substances can also form strong bonds with nanoparticles).

Now one of the most discussed, most exciting is the topic of the use of nanorobots in nanomedicine and nanochemistry, where the "talents" of nanorobots could be fully applied. It is believed that a nanorobot introduced into the human body will be able to independently move through the circulatory, lymphatic and nervous systems without harming the body, change the characteristics of tissues and cells, destroy microorganisms, viruses and cancer cells.

In the field of biology, it will become possible to “introduce” into a living organism at the level of atoms. The consequences can be very different - from the "restoration" of extinct species to the creation of new types of living beings, biorobots.

Conclusion. The prospects for the nanotechnology industry are truly grandiose. Nanotechnology will radically change all spheres of human life. On their basis, goods and products can be created, the use of which will revolutionize entire sectors of the economy. Nanotechnology provides great opportunities for medicine, chemistry and biology. In the near future, nanorobots will be developed that will give impetus to modern medicine. New materials will make it possible to improve many inventions. The use of nanotechnologies for purification and disinfection of water is also of great importance. The introduction of membrane cleaning systems and special biocidal coatings and materials based on silver makes it possible to simplify the maintenance of farm animals and improve their quality by providing them with high-quality drinking water.

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