IMPACT OF NANOTECHNOLOGY DEVELOPMENT ON ECOLOGY AND ENVIRONMENT

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Abstract: The study examined the impact of nanotechnology on the environment and ecology. It was found that smaller-sized materials are more active, hence nanomaterials have a significant impact on the environment. The study highlighted the importance of observing safety protocols when handling nano-sized materials. Furthermore, the study explored the resistance of nanomaterials to external factors such as pressure, temperature, and radiation. It was discovered that despite their high activity, nanomaterials are resistant to external influences and tend to maintain their shape and size. The use of bionanomaterials in medicine was found to solve several issues. The study also identified new opportunities and challenges that arise from the use of nanomaterials. Lastly, the study investigated different physicochemical properties of metal and metal oxide nanoparticles and indicated the issues surrounding their disposal.

Keywords: Nanomaterials, ecology, environment, disposal, external influences.

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Received: 15 January 2023; **Accepted: 28 March 2023;** **Published: 30 March 2024**

DOI: 10.54414/RMBE7956

Introduction:

Nanotechnology has enabled new research in various areas. The study of materials at the nanoscale has revealed that their physicochemical properties change when they become smaller. Some materials become more active at smaller sizes, thus allowing us to discover new functions in them (Wongkaew, 2019; Gupta, 2022; Shah, 2020). Metals are commonly used materials due to their electrical conductivity and are used for the transmission of electrical energy. Aluminium and copper are the most commonly used metals in appliances and devices. The mechanical strength of metals allows them to be used in various devices as a defence system. Iron and steel, for example, can be used to obtain construction materials of different heights. However, recent studies have shown that metal nanoparticles and composite materials based on them have different properties. Metal nanoparticles are quite resistant to external influences, making them useful for various applications. When aluminium nanoparticles with a size of d = 40-60 nm were irradiated with an electron flood of energy E = 2-3 MeV at different intensities ($\Phi = 4.16\cdot10^{16}$ cm^{-2}, $1.2\cdot10^{17}$ cm^{-2}, and $1.03\cdot10^{18}$ cm^{-2}), no major changes occurred in their crystal structure (Abdullayeva, 2020; Jabarov, 2021). These nanoparticles have a highly symmetrical cubic structure that is resistant to electron flow, oxidation, and external influences. Although a small amount of oxidation is observed on their surface, the material retains its chemical properties. Similar properties are observed in differential thermal analysis studies conducted at high temperatures. Despite the increase in temperature, there is no structural phase transition, and the cubic symmetry is maintained (Abiyev, 2021).

Aluminium nanoparticles have a wide range of applications in producing composite materials. By adding aluminium nanoparticles to polymers, the electrical conductivity of the composite materials increases, making them electrically active (Gojayev, 2020). Polymer nanocomposite materials have higher flexibility and resilience to various external influences, making them suitable for use in devices where conventional aluminium wires cannot be used. Additionally, thin layers of materials with interesting physical properties have been widely studied due to the optical properties found in them. These discoveries expand the application possibilities of thin layers of materials (Ibrahimova, 2024).

Ongoing research is focused on studying nanomaterials and discovering their new functions. However, it is important to study the harmful effects of these materials as they retain their activity even after use. Nanoparticles are small enough to easily enter living organisms, which are typically made up of micrometre-sized cells. Therefore, living organisms should be excluded from nanomaterials. It's crucial to avoid touching nanoparticles by hand, as they can enter the body when we breathe. When working with them in labs to study their physicochemical properties, it's necessary to use masks and gloves. This study aims to investigate the impact of nanomaterials on ecology and the environment.

Research methods:

The study of environmental problems and the impact of nanomaterials on the environment has been carried out using various methods. The study examined the development stages of nanotechnology and the research methods and objects used in this field and analyzed the results obtained. It is known that as the properties of materials are discovered, new research methods are developed based on them. These new research methods allow for more accurate results. Therefore, the working principles and research possibilities of high-precision electron microscopes, atomic force microscopes, and tunnelling microscopes were defined. The obtained results were analyzed and new results obtained during the study of nanomaterials were investigated. The ecological problems of this data were investigated, and the difficulties arising due to smaller sizes were highlighted. It is important to note that all objects existing in nature are influenced by the environment. As a result of these effects, there is an interaction between substances and the environment. This interaction can lead to two cases: firstly, changes in the substance caused by the environment, and secondly, changes in the environment caused by the substance. In this study, each of these cases was investigated separately.

Results and discussions:

Nanomaterials are widely used in various fields, particularly in modern electronics. However, when electronic devices that use these materials reach the end of their service life, they can pose a risk to the environment. Disposing of nanomaterials can be challenging because of their hazardous nature. Capacitors are a common component in electronic devices, and capacitors made using nanomaterials are increasingly popular. Figure 1 shows a conventional capacitor and a capacitor made using nanomaterials.

Although these capacitors serve the same purpose, they differ in size. By purchasing thinner layers, it's possible to acquire multifunctional capacitors, leading to smaller-sized modern devices. Televisions have also undergone miniaturization due to obtaining functional properties in smaller sizes. By replacing the electron beam with smart screens, a better-quality image is achieved. Therefore, research is continuing to study known materials at the nanoscale.

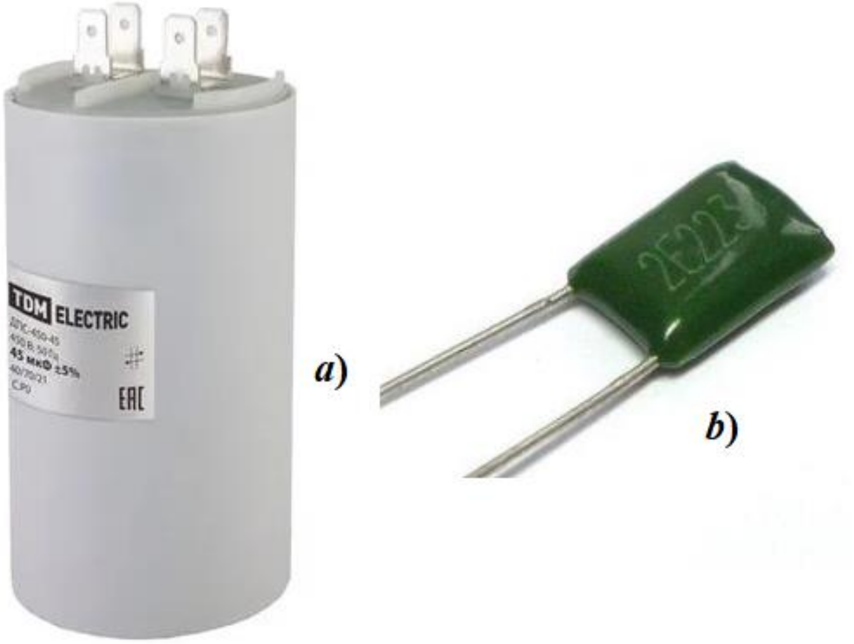

Figure 1. Conventional (a) and nanomaterials (b) capacitors.

With the advancement of nanotechnology, researchers have observed changes in the devices used for research. Figure 2 displays electron microscopes. In Figure 2a, an electron beam tube-based electron microscope is depicted. This device is relatively large and can provide enlarged images of research objects via its screens. Figure 2b shows a modern scanning electron microscope that has been made using nanomaterials. This microscope can be used to analyze not just the surface structures of materials, but also their chemical composition. This method can also be used to ascertain the percentage of chemical elements present in the sample being analyzed.

Atomic Force Microscopes (AFMs) allow for more extensive research, making it possible to study the surface structure of nanomaterials in 3D format. This leads to obtaining more information about the surface relief of these materials.

When compared to older devices, modern AFMs differ in terms of volume, functions, and accuracy. This is due to the advancements in nanotechnology. However, as nanotechnology progresses, it becomes increasingly important to consider the relationship between nanomaterials and nature. Powdered nanoparticles can easily enter living organisms, which is why safety rules should be followed when purchasing, studying, and applying these materials. Moreover, these materials should be properly disposed of at the end of their useful life. End-of-life devices should be disposed of in special containers, and many devices, such as electric batteries, have a special symbol indicating that they should not be placed in the same container as other waste.

New types of detergents have recently been introduced for car washing that creates a chemical layer on the surface of the car. This layer helps prevent dust particles and rainwater from sticking to the car and protects it for up to seven days. However, using these detergents can harm the environment as the thin layers formed on the surface are later thrown into the environment. Similarly, nanotechnology-based paints can be used to protect buildings from pollution, but these materials may undergo chemical transformations over time.

As technology continues to advance, we are discovering new environmental problems, and the development of nanotechnology is no exception. The primary concern is that nanomaterials, being smaller and more active, can have a greater impact on the environment. Therefore, it is not acceptable to dispose of them carelessly.

a)

b)

Figure 2. Electron microscope (a) and Scanning Electron Microscope (b).

Research into bionanomaterials is a key area of nanotechnology, which has helped solve many medical problems. The use of these materials has led to the development of new implants and nanocomposites, which are widely used in medical devices and the preparation of implants (Velu, 2022).

Conclusıon:

During the research, modern research methods and their possibilities were investigated. The advantages and disadvantages of nanotechnology were studied, and its impact on ecology and the environment was analyzed. It was discovered that materials with smaller sizes have more active physicochemical properties. The comparison of standard and nanotechnology transducers revealed a decrease in the volume of converters and an increase in functions. The side effect of nanotechnology was analyzed through the comparison of electron microscopes, which showed modern electron microscopes to be multifunctional devices capable of analyzing both surface structure and chemical composition.

The study also investigated the relationship between detergents and paints obtained through nanotechnology and their impact on the environment. It was determined that these materials are chemically active substances that can affect the environment after a certain period. The adverse effects of these materials become inevitable after their useful life, and their disposal should be considered simultaneously with their use to prevent any environmental harm.

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