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Use of Nanotechnologies in the Field of Construction Material Science

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Abstract: This article analyzed the theoretical and practical issues of the use of nanotechnology in solving the main problems of the field of construction materials and environmental protection. It is said that nanotechnology has a huge economic potential for use in all areas, and it helps to increase efficiency and environmental cleanliness at all stages

Key Words: Nanotechnology, technology

Nanotechnology is a new field of science and technology that has been actively developing in recent decades. Nanotechnology involves the creation and use of materials, devices, and technical systems defined by nanostructures, i.e., its ordered particles with sizes ranging from 1 to 100 nanometers.

Currently, nanotechnologies are recognized as the most promising field of scientific and technical development.

Nanotechnologies are now widely used to solve problems in various fields, including in physics and chemistry: in studying the properties of various nanoobjects (fullerenes, nanowires, graphene, heterosystems, other small-sized objects); In industry: in the creation of ultra-strong and ultra-light materials (material science) and nanocatalysts, nanosorbents, filters with a specific surface area of 600 m2/g; In the military field: in the use of nanoparticles (aerosol) for degassing and disinfection in military industrial facilities and in emergency situations, in the preparation of metamaterials for masking various objects and armor for the protection of fighters, parts of military equipment (robots, aircraft, missiles, etc.) in obtaining materials for preparation (carbon plastics); In the fields of agriculture and food: farming, animal husbandry, poultry farming, fisheries, veterinary medicine, storage and processing of agricultural products, improving the hydromelioration condition of the soil, fighting against sand and landslides; In medicine and pharmaceuticals: in the preparation of nanostructured drugs (medicine, biology) that are quickly delivered to the circulatory system, as physical means to destroy cancer cells, in the creation of gauzes and clothes with antimicrobial properties, and in the creation of nanorobots to cut damaged cells; In electronics and computers: in the manufacture of magnetic memory elements with very large capacity for high-speed computers - triggers, in the development of lasers and light-emitting diodes (nanoelectronics) based on atomic-molecular design (integrated circuits, sensors) and quantum dots in emission, creating photon crystals (photonics); In the field of energy: use of solar photoelectric devices and alternative energy sources, creation of thermoelectric materials for energy saving and uranium packaging (nanotubes); In environmental protection: "artificial nose" highly sensitive to various chemicals (Langmuir-Blodget layers) and in the fight against sand and soil landslides.

The practical importance of nanotechnology includes the production of devices and their components.

The rapid development, introduction and use of nanotechnologies in production, as well as the risks (social, ethical and environmental) associated with them are relevant in solving the problems of a certain technological direction and the relevant field of activity, including in the construction materials industry.

The production of products using nanomaterials for building construction enables the improvement of many unique properties of building materials, including lighter and stronger structural composites, low-cost technical coatings, better cementitious materials, low heat transfer, fire resistance and insulation, good sound absorbing acoustics. such as producing absorbers and reflective glass materials. Because particle size is a critical factor, material properties are significantly different at the nanoscale than at the larger scale. Below

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the limit, physical phenomena begin to occur in a different way: gravity becomes insignificant, electrostatic forces and quantum effects begin to be observed.

In this case, the proportion of atoms on the surface increases compared to those inside, and this is called the "nano-effect". All these nano-properties affect the characteristics of materials on a macro scale and new materials can be developed.

Some important nanomaterials that can be used in construction are listed below.

Nanotechnology for concrete.

Concrete is a macromaterial, and its nano properties have a strong influence. The addition of nanosilicate (SiO2) disrupts the calcium silicate hydrate reaction by leaching calcium in water, blocking water penetration and resulting in increased durability. Adding a small amount (1%) of carbon nanotubes improves the mechanical properties. The use of nano-SiO2 can significantly increase the compressibility of concrete containing large amounts of fly ash. Amorphous nanosilicate dispersion is used to increase the segregation resistance of self-compacting concrete. It has also been reported that the addition of small amounts of carbon tubing (1%) by weight can increase both compressive and flexural strength.

Nanotechnologies for wood.

Nanoscale surfaces of wood nanotubes or "nantolas" are self-sterilizing surfaces, internal self-healing, highly effective water containing silicon and aluminum nanoparticles opens up new possibilities for equipment such as impermeable coatings. Nanotechnology for glass leads to the application of TiO2 nanoparticles in glasses.

Photocatalytic reactions of nanoparticles occur in self-cleaning technology.

Disintegration of organic pollutants, volatile organic compounds and bacterial membranes is observed. In addition, TiO2 is hydrophilic, water forms droplets and then washes away the particles. Fire-resistant glass is produced using nanoparticles. Fumed silicon oxide (SiO2) is a transparent layer sandwiched between two glass panels, which when heated becomes a solid and opaque fire screen.

Nanotechnology for thermal insulation.

Ultra-thin wall insulation using a hydrophobic nanostructure as a means of protection has been created. It is a silica-based product for transparent insulation, leading to the possibility of creating super-insulating windows.

Micro- or nano-electromechanical systems provide the ability to monitor and control the indoor environment of buildings, which can significantly contribute to energy savings.

Nanotechnology for fire protection.

The fire resistance of steel structures is often provided by a cement-based coating.

Nanocement made of nano-sized particles is a strong, durable, high-temperature coating. This is achieved by mixing carbon nanotubes (CNTs) with a cementing material to form fiber composites that incorporate some of the beneficial properties of nanotubes, such as strength.

Advantages of nanotechnology in construction:

Construction nanotechnology can be used in design and construction processes in many areas, because the products produced with nanotechnology will have many unique properties.

Using nanotechnology in construction materials, products can be obtained: lighter and stronger structural compositions; maintenance coatings; improvement of materials and pipe connection methods; improving the properties of cement materials; reduction of fire resistance and thermal conductivity of insulation; increase the sound absorption of the acoustic absorber; such as increasing the reflectivity of glass materials.

The construction sector deals with a large amount of raw materials, and various innovative materials are already used in modern construction and have begun to contribute to the formation of the architecture of the future.

The future of construction material science is mainly related to the use of nanotechnological approaches - the introduction of modern building materials structure formation processes, their "bottom-up" assembly or self-assembly. material or product design that has a controlled and controlled effect on the structure process from the nanoscale level. The result of this approach will be to obtain structural, heat-insulating, finishing materials and other materials, which differ in composition and quality, fully complying with modern trends in the development of architectural forms, design solutions and technology.

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Nanomaterials for construction, autonomous energy sources based on powerful solar panels, nanofilters for water and air purification - these advances in nanotechnology should make our homes more comfortable, reliable and safe.

Adding nanoparticles of various materials to concrete makes it several times stronger. Nano-coatings are being produced to protect concrete structures from water. Steel, the most important construction material, is also much stronger with the addition of vanadium and molybdenum nanoparticles. Self-cleaning glass with titanium dioxide nanoparticles is already available in the industry. Nanofilm coatings for glass optimally regulate the flow of light and heat through the window.

To protect buildings from fire, nanotechnology offers new non-combustible materials (for example, cable insulation containing clay nanoparticles) and "smart" networks of highly sensitive fire nanosensors. Zinc oxide nanoparticulate wallpaper helps keep bacteria at bay.

Today, there is a wide range of industrially produced nanomaterials on the market: metal, hydroxides, oxides and composite powders, which are already widely used in many areas of industry and construction. Nano-dusts have properties that differ from the properties of metals, oxides, etc., from the atoms and molecules from which they are made. In addition, most of such properties have not yet been fully explored. And in the future, it is possible to replace the currently accepted manufacturing methods by assembling any mechanical devices directly from atoms and molecules using nanorobots.

Wide-scale use of nanomaterials in the construction industry is limited due to the following reasons: 1) lack of information about nanomaterials suitable for construction and their characteristics; 2) lack of special standards for the design of construction elements using nanomaterials and their use; 3) decrease in recommendation of nanoproducts; 4) lack of detailed information on the composition of nanoproducts; 5) highexpenses; 6) unknown health risks associated with nanomaterials.

Today, nanotechnology is one of the most actively developing and useful fields of science, which has been gradually formed over the past two decades. Recent research in the field of nanomaterials and nanotechnologies has revealed the possibilities of using these materials in various fields such as medicine, construction, automotive, energy, telecommunications and informatics. This is due to the unique properties of materials that appear at the nanoscale.

Nanotechnologically created products have unique properties and have proven to be able to solve many problems in the field. Changing the properties of building materials is one of the main areas of application of this research, which improves the performance of building materials such as concrete, steel, glass and insulation materials.

Currently, many construction problems can be solved with the help of nanotechnology. The use of nanomaterials in some composite materials, such as cement, leads to significant reductions in CO2 pollution, and their use in thermal insulation materials leads to energy savings.

Thus, the application of nanotechnologies in industry, construction and building materials has an important place.

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