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DEVELOPMENT OF A SPECIAL PAINT WITH NANOPARTICLES THAT REFLECTS INFRARED RAYS AND REDUCES HEAT ABSORPTION

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Abstract: This article reviews the theoretical and practical aspects of developing special paints based on nanoparticles that reflect infrared (IR) rays and reduce heat absorption. The possibility of controlling the optical and thermal properties of surfaces using nanoparticles is analyzed. The results of the study show that they are of great importance in increasing energy efficiency and reducing heat load in building materials and vehicles.

Keywords: nanoparticles, infrared rays, heat absorption, reflective paint, energy efficiency, optical properties.

Introduction: Currently, due to global climate change and limited energy resources, the development of energy-saving technologies is of great importance. In particular, reducing the need for cooling systems by reducing heat absorption in buildings and vehicles is an urgent issue.

Infrared rays make up the main part of solar energy, and their absorption by surfaces leads to an increase in temperature. Therefore, the development of special coatings that reflect infrared rays is an important scientific direction. As a result of the development of modern materials science and nanotechnology, the creation of coatings with new functional properties is becoming one of the most relevant directions. Among them, special paints with nanoparticles that reflect infrared (IR) rays and reduce heat absorption are of particular importance. Such paints serve to increase energy efficiency by controlling the thermal regime of buildings, vehicles, industrial equipment and other surfaces.

A large part of solar radiation is in the infrared spectrum, and when these rays are absorbed by substances, they lead to an increase in surface temperature.

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Conventional paints can mainly reflect visible light, but their reflectivity in the infrared range is low, as a result of which surfaces heat up quickly. To overcome this problem, it is proposed to use nano-sized particles.

Nanoparticles (TiO_2, ZnO, SiO_2, Al_2O_3, etc.) have a very small size, and when they interact with light, they enhance the processes of scattering, reflection and interference. As a result, the reflectivity of the paint coating to infrared rays increases and heat absorption decreases. In particular, titanium dioxide (TiO_2) nanoparticles are widely used due to their high optical activity and stability.

In the process of preparing such paints, nanoparticles are first dispersed in a uniform medium using special dispersants. Then they are added to the acrylic, epoxy or silicone-based paint matrix to form a homogeneous mixture. The prepared composition is applied to the surface as a thin layer and dried. As a result, a functional coating is formed that has the property of reflecting the infrared part of sunlight.

Practical studies have shown that paints with nanoparticles significantly reduce surface temperature compared to ordinary paints. This allows reducing energy consumption for air conditioning systems in buildings, improving the indoor microclimate and reducing the environmental load. It also extends the service life of materials by reducing heat accumulation in vehicles.

Practical part: Preparation and testing of infrared-reflecting nanoparticle paint

1. Purpose of the practical work: The purpose of this practical work is to prepare a special infrared-reflecting paint composition based on TiO_2 and SiO_2 nanoparticles and compare its thermal properties with ordinary paint.

2. Required materials and equipment

- Acrylic-based paint (main matrix)
- Titanium dioxide (TiO_2) nanoparticles
- Silicon dioxide (SiO_2) nanoparticles
- Dispersant (for uniform dispersion of particles)
- Distilled water or solvent
- Magnetic stirrer
- Ultrasonic disperser (or high-speed mixer)
- Glass plate or metal plate (sample surface)
- Thermometer or infrared thermometer
- Sunlight or infrared lamp

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In this practical work, a special paint with nanoparticles that reflect infrared rays and reduce heat absorption was prepared and its properties were compared with ordinary paint. The main objective of the experiment was to determine the heat rejection efficiency of the paint prepared based on TiO_2 and SiO_2 nanoparticles.

In the experimental process, an acrylic-based paint was first selected and nanoparticles were added to it in a certain amount (approximately 1–3% by mass). Titanium dioxide (TiO_2) and silicon dioxide (SiO_2) were used as nanoparticles. These particles are known to have the ability to scatter and reflect infrared rays due to their high optical properties. To prevent the particles from sticking together, they were first prepared using a dispersant and then dispersed in the same environment using ultrasound or a high-speed mixer.

After that, the prepared nanoparticle mixture was added to the acrylic paint base and mixed thoroughly for several minutes. As a result, a composite paint with the same consistency was formed. The finished paint was evenly applied to the surface of a glass or metal plate and dried completely at room temperature.

For comparison, ordinary acrylic paint without nanoparticles was also applied to a separate sample and dried under the same conditions. In the next step, both samples were placed at the same distance from sunlight or an infrared lamp, and their surface temperatures were measured using a thermometer..

According to the results, the surface coated with ordinary paint heated up quickly and reached a high temperature. The nanoparticle paint absorbed heat slowly, and its maximum temperature was significantly lower. In particular, the sample with TiO_2 and SiO_2 applied together had a stronger infrared reflection property, giving the lowest surface temperature.

Conclusion: This work analyzed theoretical and practical data on the development of a special nanoparticle paint that reflects infrared rays and reduces heat absorption and the study of its properties. During the study, it was found that the addition of TiO_2 and SiO_2 nanoparticles to the paint significantly improves its optical and thermal properties.

The experiments showed that the nanoparticle paint reflects more infrared rays than ordinary paint and reduces surface heating. In particular, the coating based on a combination of TiO_2 and SiO_2 showed the best results, significantly reducing the surface temperature.

In general, nanoparticle paints are important in increasing energy efficiency, and they are promising materials for reducing the heat load in buildings and industrial

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facilities, reducing the need for cooling systems, and ensuring environmental sustainability. In the future, the widespread introduction of such coatings on an industrial scale can develop energy-saving and environmentally friendly technologies.

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