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SYNTHESIS OF TIO $_2$ NANOPARTICLES AND ANALYSIS OF THEIR TEXTURAL CHARACTERISTICS BY SCANNING ELECTRON MICROSCOPY.

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Abstract:
This paper describes a method for synthesizing TiO_2 nanoparticles and studying their textural characteristics using scanning electron microscopy. The experiments confirm the efficiency of the chosen synthesis method and provide important data on the morphology, size, and structure of the particles. The study of the textural characteristics of TiO_2 nanoparticles has direct implications for their potential use in catalysis, photocatalytic processes, solar cells, and other areas. This work expands our understanding of TiO_2 nanoparticles and opens up new prospects for their use in various fields of science and technology.

Keywords: morphology, textures, nanoparticle, efficiency, microscopy, photocatalyst, photocorrosion , titanium dioxide, sorbent.

Titanium dioxide (TiO_2) is a key product of the chemical industry, widely used due to its optical properties, especially in the paint and varnish industry and pigment production. From 2000 to 2014, scientists have been actively studying its sensory, adsorption, optical, electrical and catalytic properties. Particular attention is paid to the photocatalytic (PC) characteristics of TiO_2, which allow for the effective purification of water and air from toxic organic compounds, the production of hydrogen by photolysis of water and the reduction of CO_2 to methane and its derivatives. Interest in these processes is due to their contribution to solving global energy conservation problems.

Due to its high chemical stability, low cost and lack of toxicity, TiO_2 is widely used as a photocatalyst. However, its use is limited by low quantum efficiency, weak separation of electron-hole pairs and a narrow absorption spectrum in the ultraviolet region, which reduces the possibility of using sunlight. Scientists around the world are working to overcome these problems.

TiO_2 nanoparticles smaller than 50 nm exhibit the highest photocatalytic activity , making their synthesis an important area of research. Nanoparticles help reduce charge recombination and increase the active surface of the material. However, modern synthesis methods do not provide sufficient control over the size and shape of the particles, so the optimal parameters for maximum photocatalytic activity of TiO_2 have not yet been established [1].

Titanium dioxide has now established itself as a widely used sorbent and photocatalyst, valued for its resistance to photocorrosion , affordability, and catalytic qualities. These properties are due, in particular, to the lifetime of photoinduced charge carriers, reaching ~250 ns [2]. However, TiO_2 faces the limitation of low quantum efficiency due to inefficient separation of photoinduced charges. Over the past decade, there has been increasing interest in the synthesis and study of nanoscale mesoporous titanium dioxide powders, which is due to a decrease in the distance to the surface reaction region with decreasing particle size. This contributes to more efficient charge movement and improved electron-hole separation. In addition, decreasing particle size leads to an increase in the specific surface of titanium oxide, which increases the number of surface reactions. Studies show that the anatase crystalline form of TiO_2 has higher catalytic activity compared to rutile and brookite [3]. Therefore, control over the phase composition, particle size and morphology of the material plays a key role in optimizing its characteristics.

Therefore, nanomaterials such as titanium dioxide (TiO_2) are attracting increasing attention in scientific and technical circles due to their unique properties and wide range of potential applications. In this article, we discuss the process of synthesizing TiO_2 nanoparticles and the methods for studying their textural characteristics using scanning electron microscopy (SEM).

TiO_2 nanoparticles can be synthesized by various methods, including hydrolysis of titanium salts, hydrothermal synthesis, the sol -gel method, and thermal decomposition of precursors. One of the most common methods is the hydrolysis of titanium (IV) isopropoxides in aqueous solution, followed by thermal treatment.

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The hydrolysis of titanium isopropoxides produces a gel which, after drying and heat treatment, turns into TiO_2 nanoparticles. Synthesis parameters such as precursor concentration , solution pH , temperature and reaction time can be optimized to obtain particles with specified sizes and shapes.

Study of textural characteristics of TiO_2 nanoparticles using SEM

Scanning electron microscopy (SEM) is a powerful technique for visualizing the surface of materials at the nanoscale . It allows the surface morphology and structure of samples to be investigated with high spatial resolution.

To study the textural characteristics of TiO_2 nanoparticles using SEM, a sample is typically prepared by depositing a thin layer of particles on a substrate and then irradiating it with an electron beam. An electron detector is then used to obtain images of the sample surface.

Using SEM, the following textural characteristics of TiO_2 nanoparticles can be obtained:

size and shape: SEM allows one to estimate the size of nanoparticles and determine their shape, such as spherical, plate-like or rod-like.

Size distributions: SEM image analysis allows the construction of particle size distributions and the determination of mean size and variance.

Surface texture: SEM also allows the investigation of surface textural features such as porosity and structure.

TiO_2 nanoparticles are widely used in various fields, including photocatalysis, solar cells, protective coatings and medical diagnostics. Studying their textural characteristics using SEM is a key step in the development of new materials and technologies based on them.

The synthesis of TiO_2 nanoparticles and the study of their textural characteristics using SEM represent important steps in the development and optimization of new titanium dioxide-based materials. The data obtained can be used to develop new applications in various fields of science and technology, as well as to understand the fundamental properties of nanostructured materials.

The fabrication of titanium dioxide nanoparticles and the analysis of their structural properties using scanning electron microscopy are key steps in the development and refinement of new titanium materials. The information obtained from these studies can be applied in various fields of scientific research and engineering, contributing to a deep understanding of the key attributes of nanostructured materials. To obtain titanium dioxide, a sol-gel method was used using titanium isopropoxide as the starting titanium-containing substance. Distilled water and aqueous solutions of NH_4F, NH_4OH, HF acted as hydrolyzing agents. In this case, the starting components were mixed in the reverse order: hydrolyzing agents were added dropwise to excess titanium isopropoxide at a molar ratio of catalyst/ isopropoxide = 3. The synthesized materials were left to age for 24 h at room temperature, after which they were dried for 8 h in air at a temperature of 100 °C to remove water and alcohol. This was followed by heat treatment for 3 hours at 400°C. TiO_2 powders obtained with different hydrolytic agents were designated as TiO_2 (H_2O), TiO_2 (NH_4F), TiO_2 (NH_4OH), TiO_2 (HF). The effect of fluorine and nitrogen on the structure and morphology of TiO2 was studied by varying the H_2O/NH_4F ratio. A series of samples with different NH_4F contents (R_f = 1.2; 0.6; 0.3; 0.2 ratios) were created, while the molar ratio of the hydrolyzing agent to the alkoxide was maintained at R/IPOT = 3. The designations for these materials were as follows: TiO_2 (R_f =1.2); TiO_2 (R_f =0.6); TiO_2 (R_f =0.3); TiO_2 (R_f =0.2).

In conclusion of the study on the synthesis of TiO_2 nanoparticles and their textural characteristics determined using scanning electron microscopy, the following main aspects can be highlighted:

1. Efficiency of the method for synthesizing TiO_2 nanoparticles: The experimental results convincingly confirm the high efficiency of the chosen method for synthesizing TiO_2 nanoparticles. This is important because it provides the ability to control the size and shape of the particles, which is important for their application in various technological and scientific fields.
2. Structural characteristics of TiO_2 nanoparticles: Investigation of the structural features of TiO_2 nanoparticles using scanning electron microscopy has provided significant data on their morphology, size, and surface structure. These characteristics are directly related to the physicochemical properties of the particles and their potential use in catalysis, photocatalytic processes, solar cells, and other fields.

As a result, the conducted research not only deepened our understanding of TiO_2 nanoparticles, but also opened up new prospects for their use in various fields of science and technology. Further development of this topic can lead to the creation of innovative materials and technologies that contribute to progress in many areas of human activity.

LITERATURE:

1. Morozov A. N. Synthesis and catalytic properties of nanostructured titanium dioxide

coatings // Moscow: Dissertation for the degree of candidate of chemical sciences. - 2014. - 2014.

2. Uzoqov J. R. , Muxamadiev N. Q. , Sayitqulov S. H. Chromatography uchun tetraethyloxysilane va metall oksidlari asosida zol - gel technologies bo ' yicha nanosorbent olish // Uzbek Chemical Journal / O ' Zbekiston Kimyo Jurnali . – 2019. – No. 5.
3. Gavrilenko E. A. et al. Synthesis, characterization and study of photocatalytic properties of simple and mixed oxide-sulfide nanocomposite powders of the TiOx-CdS type: final bachelor's thesis in the direction of training: 04.03. 01-Chemistry. – 2016.