

## INVESTIGATION OF TITANIUM DIOXIDE DOPED BY CARBON AND SULFUR AS PHOTOCATALYST

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The photocatalysts based on TiO<sub>2</sub> doped with non-metal (carbon and sulfur) has been obtained using modified sol-gel method and mechanochemical treatment. Analysis of SEM-images of the samples shows that they consist of roundish and fragmented agglomerates in the range of 5–30 μm which consist of the particles of 14 nm in size. Modification with carbon leads to an increase in particle size: as the amount of carbon increases from 1 to 21 mass. %, the particle size increases from 14 to 19 nm. Sulfur additives inhibit grain growth of TiO<sub>2</sub> and form the particles of 9–10 nm in S/TiO<sub>2</sub> composites. Simultaneous modification of TiO<sub>2</sub> with carbon and sulfur leads to the formation of particles with a size of 7–8 nm.

It was found that additives of carbon into the binary composites lead to anatase formation. XRD show the reflexes of anatase and rutile phases regardless of sulfur concentration in S/TiO<sub>2</sub>. The addition of C (1.5 mass. %) and S (from 0.6 to 9 mass. %) into ternary composites practically does not influence on the TiO<sub>2</sub>, but an increase in sulfur amount (12 and 15 mass. %) in the samples leads to appearance of rutile reflexes. Thus, an increase of the sulfur amount in the ternary samples leads to the formation of rutile structure. During doping and co-doping of TiO<sub>2</sub> with carbon and sulfur using mechanochemical treatment, the formation of new phases does not occur.

All composites show the presence of a hysteresis loop which is the evidence for mesoporous structure of the powders. The modification of TiO<sub>2</sub> by carbon and sulfur leads to increase of specific surface area (of about 3.3 times for S/TiO<sub>2</sub> and about 4.7 times for C/S/TiO<sub>2</sub>), average pore volume and decrease of radius pore volume compared with TiO<sub>2</sub>.

It was identified C–C, C–O, O–C=O, C–H i –CH<sub>2</sub> bonds on the surface of C/TiO<sub>2</sub>, S/TiO<sub>2</sub> and C/S/TiO<sub>2</sub> samples and also S=O, S–O on the surface of S/TiO<sub>2</sub> and C/S/TiO<sub>2</sub> powders which obtained by sol-gel method and C=O bonds on the surface of C/TiO<sub>2</sub>, S/TiO<sub>2</sub> and C/S/TiO<sub>2</sub> samples and S<sup>2-</sup> and -NH<sub>2</sub> on the surface of S/TiO<sub>2</sub> and C/S/TiO<sub>2</sub> powders which obtained by mechanochemical treatment.

Absorption spectra of nanocomposites showed a bathochromic shift as compared with the absorption band of pure TiO<sub>2</sub> and band gap narrowing which explained by rutile formation.

Nanocomposite samples showed higher adsorption and photocatalytic activity compare with pure TiO<sub>2</sub> and P25 (in the presence of the best samples in 1 hour there is a destruction of 99 % of the dye), which is associated with a decrease in particle size, increase in specific surface area and narrowing of the band gap. Correlation of photocatalytic activity with adsorption capacity indicates that photocatalytic transformations occur on the surface of the powder. It was found that samples of TiO<sub>2</sub> modified with C and S show photocatalytic activity under visible irradiation in the destruction reaction of Safranin T, which is explained by their sensitization to visible light by the adsorbed dye. It is shown, that TiO<sub>2</sub> modified with activated carbon shows higher photocatalytic activity in photocatalytic hydrogen evolution from alcohol-aqueous solutions compared to pure TiO<sub>2</sub> and P25.