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Study of Highly Defective Titanium Dioxide Prepared via Pulsed Laser Ablation

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Nowadays nanodispersed titanium dioxide is widely used in photovoltaic devices, in the "green technologies" of solar energy, as well as in the production of bactericidal materials and sunscreens [1, 2]. Currently, new technologies are developed to obtain titania-based materials, which absorb light in the visible region and exhibit high photocatalytic activity. We obtained superfine dark blue titanium dioxide with intense absorption in the visible spectral range using pulsed laser ablation (PLA) method [3]. TiO_2 powder was synthesized in the following way. At first, a colloidal solution of Ti in distilled water was obtained by PLA using Nd:YAG laser (wavelength of 1064 nm, frequency of 20 Hz, pulse duration of 7 ns). Then the colloidal solution was dried at 60 °C. After that, the powder was annealed at different temperatures.

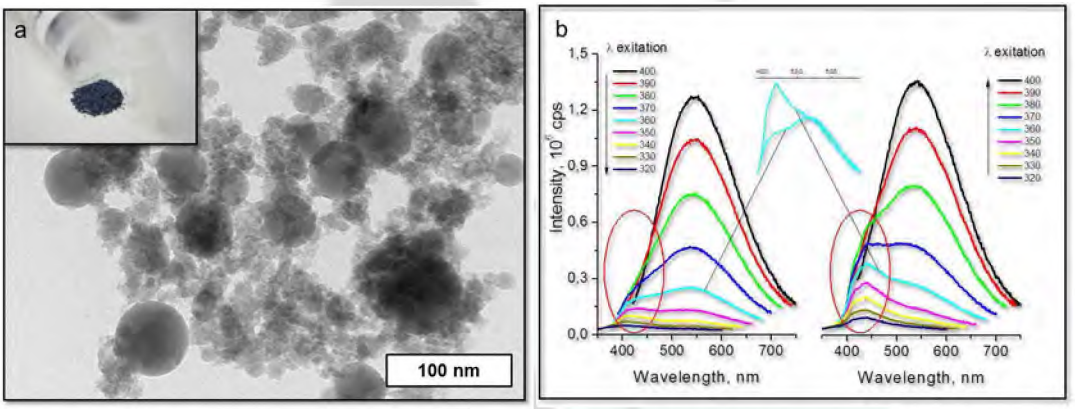

Figure 1 TEM image (a) and photoluminescence spectra (b) of TiO_2 powder.

The initial TiO_2 is a dark blue powder (figure 1a) having spesific surface area of 227 m^2/g. It consists of the spherical particles with an average size of 5-10 nm, and an insignificant number of large particles with a size up to 80 nm. The initial material is X-ray amorphous, and only after annealing at 400 °C the phases of anatase 67 % and rutile 33 % are formed. Also, after annealing the sample color changes to light grey at 400 °C and becomes white at 600 °C. It was found, that TiO_2 DRS spectra showed an intense additional absorption in visible region. This is due to the presence of defects of various nature in the structure of TiO_2. The fluorescence bands (figure 1b) in the 380-800 nm region belong to different types of oxygen vacancies (F, F^+ and F^{2+}centers) and self-trapped exiton states (STE). It was found that the emission spectrum varies its profile depending on the increase (from 320 to 400 nm) or decrease (from 400 to 320 nm) of the excitation wavelength. This change in the spectrum is associated with a relatively long lifetime of STE states.

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