Hydrothermal synthesis of photocatalytic anatase nanopartilces

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An attractive solution of the problem related to the purification of organic pollutants in wastewaters or gases involves their photocatalytic decomposition using titanium dioxide (TiO_2) as a photocatalyst. Anatase modification of titanium dioxide is very important among photocatalysts due to its chemical stability, relatively low production cost and non-toxicity. Under UV light illumination, anatasee nanopartides became strong oxidizing agent with ability to totally decompose and mineralize the organic compounds and even microorganisms.

Photocatalytic activity of titanium dioxide strongly relies on its crystallinity and specific surface area. According to literature, the nanoparticles of anatase in the size range between 20 and 40 nm exhibit the highest photocatalytic activity. If particles are smaller, their photocatalytic ativity is reduced due to poor crystallinity, and when their size is above approximately 40 nm, their surface area is reduced.

Among different reaction processes, hydrothermal process has shown great promise producing highly active anatase compound, at relatively low temperature, without any high temperature annealing. The synthesis is preformed in a sealed reactor at an elevated temperature and pressure. The method is simple, inexpensive and can be used on an industrial scale. The nanoparticles can be obtained in form of colloidal suspensions, which is especially beneficial for their further treatment, for example, for the functionalization of their surfaces.

In our work, we synthesized anatase nanoparticles using hydrothermal synthesis. The synthesized anatase nanoparticles have narrow size distribution. By systematically changing the different reaction parameters (temperature, reaction time, pH, concentration) we synthesized nanoparticles in the size range between 15 and 40 nm.

The major characteristics, which define the photocatalytic activity of synthesized nanoparticles, are crystal modification, their size and size distribution, morphology and surface charge, which enables the preparation of their stable suspensions. The phase composition and average diameter of the synthesized particles were determined using X-ray diffractometry, and the morphology and size of the particles were determined using transmission electron microscopy.