PhD thesis abstract

Preparation and investigation TiO_2-based photocatalysts active in the visible light

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The subject of presented doctoral thesis is preparation and study titanium photocatalysts which capable of decomposing contaminants present in the water and gas phases under visible light. Three groups of TiO_2 photocatalysts were obtained: rutile structure, copper modified and ammonia gas modified.

Rutile-type TiO_2 and copper-modified TiO_2 were obtained by sol-gel method followed by heat treatment process. Titanium tetraisopropoxide was used as the titanium precursor in both cases. In the case of rutile-type TiO_2 preparation, the synthesis was carried out in the presence of glycerol. On the other hand, copper (II) nitrate was used for Cu-doped TiO_2. The modification of TiO_2 with ammonia gas was carried out for a intermediate titanium obtained from the production of titanium white in the temperature range from 300 to 700 °C.

The obtained materials were subjected to physicochemical characterizations using a variety of techniques including photocatalytic degradation of water and air model pollutants, i.e. phenol and acetaldehyde, respectively, under the influence of a glow or fluorescent lamp irradiation. To compare the photocatalytic properties of the final materials, commercial titanium photocatalysts were used: P25 and P90, Tytanpol® R-001 and KronoClean 7000 and 7050. The results allowed to determine the effect of preparation parameters on the properties of the obtained photocatalysts.

Modification with glycerine and Cu doping contributed to the improvement of the adsorption capacity, degradation and mineralization of phenol under influence of the incandescent lamp irradiation. It was found that, the high activity of glycerol modified photocatalysts was due to the size of rutile crystallites; the smaller the size, the greater the activity. Cu-doping, on the other hand, reduced band gap energy, which improved the activity of these photocatalysts under Vis irradiation. It was proved that the activity of titanium photocatalysts for decomposition of acetaldehyde depends mainly on the degree of hydroxylation of their surface; the fewer the hydroxyl groups were present on the surface of TiO_2, the greater the activity. Modification of TiO_2 with ammonia was proved to be unfavorable for the decomposition of acetaldehyde under the influence of both UV and Vis irradiation.

10.12.2018

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