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MODIFICATION OF TiO_2 PARTICLES NANOSTRUCTURE FOR PHOTOCATALYTIC APPLICATIONS

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Water treatment technologies based on the heterogeneous catalysis, specifically applied for waters containing the organic pollutants, receive special attention of the researchers in different countries. Using of the fine metal oxide particles, such as TiO_2 with nanotubular structure, is one of the most promising approaches. Photocatalytic activity of TiO_2 may be explained with that the light quanta under the UV-irradiation with the wavelength l<385 *nm,* excite the electrons, moving them from the valency zone to conductivity zone with the formation of electron-hole pairs, i.e. $TiO_2 + hv \rightarrow TiO_2(e^- + h^+)$. This promotes the formation of high reactive oxygen-containing radicals such as $^{\bullet}OH$, $^{\bullet}O_2^-$, $^{\bullet}HO_2$, $^{\bullet}O_2$- etc. in water environment [1].

Photocatalytical treatment of waters containing the persistent organic pollutants, may result in their mineralization due to the development of the reduction-oxidation processes with the involvement of active radicals. This leads to the formation of simple non-toxic compounds following the general type reaction: $^{\bullet}OH + O_2 + C_nO_mH_{(2n-2m+2)} \rightarrow nCO_2 + (n-m+1)H_2O$.

The improved methods of electrochemical synthesis of nanostructured TiO_2 were proposed. The resulted products were in the form of deposits strongly attached to Ti base, and separate particles formed in water environment [2]. The mechanism of nano-tubular TiO_2 structure formation was discussed from the point of view of the structural-geometric theory. The role of the barrier layer as well as the other factors is discussed, which determine the character of tubular structure of the anodic layers on Ti. It was shown that, independently on the anodic treatment regime, the ratio of elementary cell and applied voltage is maintained: W = 2SE + D = 2L + D, where W – cell dimension (diameter); E – oxide forming voltage; D – pore diameter; S – relative thickness of cell wall, characterizing the thickness share per each V of forming voltage; L – cell wall thickness.

Dependence of barrier layer (T) and elementary cell wall thickness is expressed by the formula: T = 1,2 L. The correlation between the pores diameter, cell diameter and thickness of barrier layer is: D = W – 1,67 T. The specific amount of nanotubes' elementary cells, calculated on the base of cell dimensions, makes $(3\text{-}5)\cdot10^8$ in 1 cm^2 and is changing in inverse proportion to voltage.

A new principle of flow-through photocatalytic reactor on the base of nano-tubular TiO_2 was developed [3]. The composite compounds production and applications was tested [4]. The developed reactor makes it possible to obtain the nano-tubes surface covered with copper layer by chemical-catalytic reduction. The TiO_2 nanotubes covered with Cu may be perspective for using in the reactors that can help to radically increase the rate of CO_2 conversion, in mixture with water vapour, in natural gas under the solar irradiation. This can help to resolve the greenhouse gases emissions problem in future.

References:

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