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Spectral characteristics of Photocatalytic constant for Titania

Advanced oxidation processes (AOPs), namely photocatalytic reactions can be successfully used in the field of wastewater treatment to reduce toxicity and to reach the complete mineralization of organic pollutants.

AOPs are the multistep photochemical process that starts with electron-hole excitation by light absorbed on the surface of photocatalyst, with subsequent water splitting in H^+ and OH^- active radicals interacting with organic pollutants presented in water, which in turn results in mineralization of pollutants.

Titanium dioxide (TiO_2) is considered as one of the most effective photocatalyst. TiO_2 is a wide bandgap semiconductor and has three crystalline forms, anatase, which considered as the most active photocatalyst, rutile, and, brookite. Great efforts have been done during the last decades to improve photocatalytic properties of TiO_2 which was prepared by different synthetic procedures in different morphological forms, like nanopowders, thin films and, doped materials, etc. Many efforts were done in attempts to increase photocatalytic efficiency in the visible light region

In this work, we perform systematic studies for the spectral dependence of photocatalytic constant of TiO_2 fabricated by different methods. Nanopowders P25 Degussa was used as a reference photocatalyst.

Other samples used in this study were prepared by the sol-gel method followed with different annealing procedures. In addition, the nanopowders P25 Degussa samples were doped with different concentrations of cobalt

(P25: Co), and the thin films were prepared by Chemical Vapor Deposition (CVD) method.

It was shown that for all wavelengths used in this study (365, 405, 436, 546 and 690 nm) the photocatalytic reaction constant is not zero but instead it increased in the shorter wavelengths for all TiO_2 nanopowders, (the energy bandgap is about 3:2 eV that corresponds to 387 nm).

Our findings are that nanopowders have some electronic states inside the energy gap between valence and conductive bands. These states can be excited by light and the electrons and holes resulting from this excitation play a significant role in Photocatalysis.

Another approach for increasing the photocatalytic efficiency is by increasing the life-time of electron-hole pairs before recombination.

This can be achieved by introducing local impurities or likewise local perturbation caused by the electric field inside the photocatalysts crystal matrix or by applying an external electrical field. Different commercial dyes were used to verify their purification efficiency from water.

It was shown that two simultaneous effects occur in water. One is the electrochemical removing of the pollutant and the other is the photocatalytic degradation of the pollutant. Furthermore, the existence of the synergetic effect is confirmed. This effect can be interpreted in the framework of electron-hole pairs separation in the electric field which results in lifetime increase, even when this field was relatively small.