Enhanced Visible-Light Activity of Surface Grafted WO_3-TiO_2 Photocatalysts

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The toughening climate condition due to consumption of non-renewable resources, rampant growth of industry, increased worldwide population, and accumulation of venture waste products cause severe environmental problems. Semiconductor photocatalysts have become major materials and potential consequence alleviation for the harvesting of sustainable energy and, additionally, degradation of common pollutants consuming only solar light.

Titanium dioxide (TiO_2) is considered archetypical photocatalytic material due to its suitable band gap structure, abundance, non-toxicity, relatively low-price and high chemical stability to issue these mutual huge problems. However, its disclosed drawbacks such as wide band gap energy, which can only be activated under ultra-violet light illumination and fast recombination of charge pairs, still extensively investigate with different promising approaches in order to enhance the photocatalytic performance.

In this present work, we have designed heterogeneous WO_3-TiO_2 based photocatalysts which have demonstrated high photocatalytic activity under visible light (VL) illumination. The WO_3-TiO_2 co-catalysts were synthesized by the simple impregnation method and Cu(II) and Fe(III) nanoclusters have been grafted on the surface of the photocatalyst, accordingly. As a case of study, the synthesized photocatalysts have been characterized by using x-ray powder diffraction (XRD), TEM UV-visible Diffuse Reflectance Spectroscopy and BET specific surface area determination. The evaluation of photocatalytic activities has been examined by monitoring the consequent degradation of organic and inorganic model compounds like nitrous oxide (NOx) and acetaldehyde under UV and VL irradiation, according to international ISO standard tests (ISO22197-1 and ISO22197-2). Concerning the photonic efficiency the highest photocatalytic activity has been observed at 2.5 wt% WO_3 (500°C, pH~2) and 0.05 wt% Fe(III), nanocluster grafted TiO_2 owing to enhanced separation and transfer of photogenerated charge carriers under VL (λ=458nm) illumination. In order to understand the photocatalytic mechanistic, electron paramagnet resonance (EPR) spectroscopy and flat band potential (Mott-Schottky method) measurements have been extensively investigated. The EPR and XRD results proved that, Fe(III) and Cu(II) species is grafted onto the surface of TiO2 as amorphous CuO or FeO(OH)-like nanoclusters, respectively.

Consequently, the results explicate that the WO_3 act as electron sink that would transfer excited electrons to the surface grafted nanoclusters. These may suppress the recombination of photogenerated charge carriers significantly, while the photogenerated holes on the valence band of TiO_2 and WO_3 can easily oxidize the pollutants.