Heterogeneous photocatalysis

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Photocatalysis is a well-studied technology, which is based on absorption of light by a molecule (catalyst) in order to power chemical reactions. Solar energy is a renewable source so photocatalysis promises a solution to annual global energy demand as the energy delivered by photons could be harvested, converted and stored through chemical bonds. In heterogeneous photocatalysis, the catalyst, reactants and products occupy different phase. Another difference with conventional catalysis is that thermal activation is replaced by a photonic activation. Semiconductors and their compounds have the role of the catalysts in the form of nanoscale particles and process can be taken place when shine light on catalysts in a solution with reactants.

Heterogeneous photocatalysis has gained acceptance against other types of catalysis because of it is a low-cost process, easy to implementation, with non-selectivity, non-toxicity and total removal of pollutant and by-products. When a semiconductor catalyst is illuminated with photons whose energy is equal to or greater than their band-gap energy 'E_G' ($h\nu \geq E_G$), there is absorption of these photons and creation of electron-hole pairs, which dissociate into free electrons in the conduction band and holes in the valence band. In the presence of a fluid phase of the reactant, an electron transfer proceeds towards acceptor molecules (reduction), whereas positive holes are transferred to donor molecules (oxidation) [1]. The efficiency of the process can be reduced by the electron-hole recombination, which corresponds to the degradation of the photoelectric energy into heat. A higher surface to volume ratio provides a dramatic increase in the surface reactivity and photocatalytic efficiency [2].

Inorganic semiconductors such as: TiO_2, ZnO, CeO_2, CdS, ZnS, have been recognized as the most successful photocatalysts for various forms of applications for example environmental cleaning, solar-energy conversion, water purification and photokilling of cancer cells. The need for more stable, efficient catalysts which can be activated more efficiently by sunlight is now the goal of researchers.

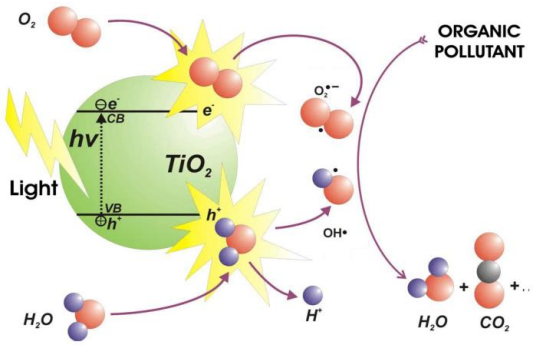

Figure 1: Mechanism of heterogeneous photocatalysis [3]

References

[1] Jean-Marie Herrmann, Catalysis Today **53**, 115-129 (1999).
[2] Ahmed and Haider, Nanotechnology **29**, 342001 (2018).
[3] Ibhadon and Fitzpatrick, Catalysts **3**, 189-218 (2013).