Photocatalytic Hydrogen Production and Water Polloutants degradation using TiO_2/Carbon allotropes

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Abstract

Over the past decades TiO_2 (P25) has been one of the most widely investigated and used photocatalytic materials, because TiO_2 is inexpensive, non toxic and chemically stable. Due to their broad applications in the fields of H_2 production, water and air purification, photovoltaic and photoelectrochemical cells, TiO_2-based nanomaterials have attracted significant research attention, However, one of the major factors that limits the efficiency of TiO_2 photocatalysis is its fast recombination of photo-generated electron/hole pairs, which releases energy in the form of unproductive heat or photons which alternatively lowers its efficiency. To solve this problem a simple and straight forward approach i.e. hydration and dehydration process to synthesize TiO_2-coated carbon allotropes is presented here. The composite showed great activity for water reduction from aqueous methanol (1 M) solution (photocatalytic reduction: PCR) and degradation of aqueous pollutants (methylene blue, and rhodamine B) (photocatalytic oxidation: PCO) under AM 1.5-light irradiation. The TiO_2 NPs-coated Carbon allotropes exhibited 30 times higher photocatalytic activity for H_2 production compared to pristine TiO2. For the dye degradation the composites showed good adsorption capacity, which further facilitated the enhancement of photocatalytic activity of TiO_2 NPs-coated Carbon allotropes for the degradation of dye molecules. The significant photocatalytic activity of the composites may be attributed to the synergetic effect of the intrinsic properties of its components such as an excellent light absorption and charge separation on the interfaces between the modified Carbon allotropes and TiO_2 resulting from direct growth of TiO_2 nanoparticles on the surface of the Carbon allotropes by a simple hydration and dehydration process.

Key words: TiO_2, Photovoltaic, photocatalysis, nanocomposites, hydrogen, absorption, adsorption.