Simultaneous Photodegradation and Hydrogen Production With TiO_2/Pt/CdS Using UV-visible light: Comparison of Polysulfide, Azodye, and Chlorophenol Additives on Hydrogen Generation

Winn Wilson,[1] Bratindranath Mukherjee,[2] and Vaidyanathan (Ravi) Subramanian[2*]

University of Nevada, Reno

Abstract

A new approach to prepare a composite using Pt and CdS with in–house TiO_2 (IH-TiO_2) having a 100% anatase content, is reported. The application of this nanocomposite powder with more than twice the active surface area of commercial Degussa P25® TiO_2 for photocatalytic hydrogen production in the liquid phase using UV-visible light is discussed. The role of a traditional sacrificial agent - polysulfide – in aiding photocatalytic hydrogen production has been examined. Further, the effects of replacing the polysulfide with representative compounds belonging to two classes of pollutants – methyl orange (MO) and 4-chlorophenol or urea (4-CP) – have also resulted in hydrogen production. Absorbance and chromatographic analyses indicates that the pollutant is degraded simultaneously as hydrogen production occurs. The hydrogen yield shows the following trend: IH-TiO_2/Pt/$CdS_{polysulfide}$ (18.5ml/hr), IH-TiO_2/Pt/CdS (7ml/hr)$_{MO}$, IH-TiO_2/Pt/CdS (5ml/hr)$_{M4\text{-}CP}$, IH-TiO_2/Pt/CdS (4ml/hr)$_{DI\ water}$. Both pollutants are observed to undergo photoconversion (X) and follow a 1st order power law degradation kinetic model with 4-CP ($X_{4\text{-}CP}$=0.7) degradation following at least one order higher rate than MO (X_{MO}=0.25). The study indicates the usefulness of TiO_2-Pt-CdS for UV-visible light assisted simultaneous clean energy production and environmental remediation. This study provides a cost effective synthesis strategy for the development of similar oxide-chalcogenide-metal nanocomposites.