

Cobalt Disulfide embedded TiO₂ Nanocomposites for Hydrogen Production under UV Irradiation

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Abstract

Hydrogen gas is greener and reliable energy source, which can contribute to fill the gap between the energy demand and energy supply. Several photocatalyst materials, such as TiO₂, ZnO, CdS, WS₂, mixed oxides, perovskites, dye and metal doped oxide materials have been used as photocatalysts for energy production, such as water splitting applications and environmental remediation. Development of efficient non-toxic photocatalyst has opened a new avenue for several other applications, such as in lithium ion batteries, solar cells, etc. The production of hydrogen through water splitting is a green route for converting solar energy directly in to clean fuel. Recently, the transition metal chalcogenides have intensively been focused on hydrogen production due to their stronger edge and the quantum confinement effect. This work mainly focuses on synthesis of cobalt disulfide (CoS₂) embedded TiO₂ nanocomposites using hydrothermal approach; and, the hydrogen production efficiencies of pure CoS₂, pure TiO₂, and different wt% of CoS₂ in TiO₂ were compared under UV irradiation. Nanocrystalline TiO₂ having 10 wt% CoS₂ exhibits higher hydrogen production of 2.5492 mmol/g_{catalyst} in comparison with the pure CoS₂ or TiO₂ used in this study. The bare CoS₂ material was found to be inactive due to its very low bandgap energy of 2.5 eV; however, the enhanced activity of the CoS₂ loaded nanocomposite may be due to the heterojunction framework that causes the effective electron-hole pair separation. In summary, the metal dichalcogenide, CoS₂, acts as an effective co-catalyst, whereas titania serves as active site by effectively separating the photogenerated electron-hole pair. This study lays down a new approach to develop transition metal dichalcogenide materials with significant bandgaps that can effectively harness solar energy for hydrogen production.

Keywords: Transition metal chalcogenides, titania, hydrothermal, hydrogen, water splitting