Title : Study of Ag, Au, and Pt Co-catalysis on TiO_2 for Enhancement the Photocatalytic Efficiency

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ABSTRACT

Hydrogen gas (H_2) is considered a highly promising clean energy source due to its environmentally friendly nature, high gravimetric energy density, and the absence of greenhouse gas emissions during combustion. However, current hydrogen production technologies predominantly rely on fossil fuels, which contribute to environmental problems. Therefore, the development of sustainable hydrogen production technologies has become a critical focus in energy research. This study investigates hydrogen production via photocatalytic water splitting using titanium dioxide (TiO_2) as a semiconductor photocatalyst. TiO_2 is widely recognized for its low cost, chemical stability, and environmental benignity. Nevertheless, its relatively wide band gap and high electron–hole recombination rate limit its photocatalytic efficiency. To enhance its performance, noble metal co-catalysts, namely silver (Ag), gold (Au), and platinum (Pt), have been deposited onto the surface of TiO_2 to reduce the charge recombination rate. In this research, the metal deposited on TiO_2 were synthesized using the hydrothermal method at 180°C for 36 h. Structural and morphological characterization confirmed the crystalline nature of the synthesized samples, while compositional analysis verified the successful incorporation of metal species onto the TiO_2 surface. UV-Vis spectroscopy revealed a slight narrowing of the band gap after metal loading. Among the prepared samples, Pt-loaded TiO_2 exhibited the narrowest band gap (3.18 eV) compared to pure anatase TiO_2 (3.22 eV). This modification improved the optical properties of the photocatalyst, making it more suitable for photocatalytic hydrogen production. Photocatalytic activity tests were conducted to evaluate hydrogen generation performance. The findings suggest that metal-loaded TiO_2 photocatalysts, particularly Pt/TiO_2, demonstrate enhanced potential for sustainable hydrogen production. This study provides valuable insights into the development of efficient photocatalysts for future clean energy applications.

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