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Hierarchical Design of Heterojunction Photocatalysts for Efficient Solar Hydrogen Production

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Abstract

The semiconductor photocatalysis is a promising approach for sustainable solar-to-hydrogen energy conversion. However, the practical use of semiconductor photocatalysts is usually hampered by poor light utilization, rapid charge-carrier recombination, and slow surface redox kinetics. Hierarchical design of heterojunction photocatalysts is an effective strategy to overcome these limitations by combining complementary semiconductor components and functional cocatalysts to enhance light absorption, charge separation, and surface catalytic activity. We report the design and synthesis of a hierarchical Ag@g-C3N4/Cu_xO-BiOCl heterojunction photocatalyst for efficient solar hydrogen production. The photocatalyst is a Cu_xO-mediated g-C3N4/BiOCl composite for direct Z-scheme charge transfer with Ag nanoparticles as cocatalyst for proton reduction. The synergistic interaction among the heterojunction components promotes efficient charge separation while preserving strong redox capability. Consequently, the optimized photocatalyst achieved a hydrogen evolution rate of 175 μmol h-1 g-1, representing a 14-fold enhancement compared with pristine g-C3N4. These results show that the hierarchical engineering of photocatalyst heterojunctions significantly improves the performance of multicomponent photocatalysts for efficient solar-to-hydrogen energy conversion.

Keywords: *carbon nitride; green hydrogen; heterojunction; semiconductor photocatalysts*