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Transition metal-doped amorphous molybdenum sulfide/graphene ternary cocatalysts for excellent photocatalytic hydrogen evolution: synergistic effect of transition metal and graphene

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Abstract

Though amorphous molybdenum sulfide (MoS_x) is considered a promising H_2 evolution cocatalyst, its intrinsic activity and charge transfer efficiency are still unsatisfactory. To overcome these drawbacks, transition metal-doped (Fe, Co, or Ni) amorphous MoS_x /graphene ternary nanocomposites were designed and fabricated using a one-step solvothermal method. Their structure, morphology, and properties were characterized. The metal-doped MoS_x nanoparticles were well distributed on the graphene sheets in the ternary composites. Metal doping greatly enhanced the intrinsic activity of amorphous MoS_x , and the integration of graphene notably promoted the separation of photoinduced carriers. The photocatalytic H_2 evolution with amorphous MoS_x as cocatalyst has been substantially improved under the synergistic effect of the transition metal and graphene. The H_2 evolution rate of Co-doped amorphous MoS_x /graphene composites reached $11.45 \text{ mmol}\cdot\text{h}^{-1}\cdot\text{g}^{-1}$ at the Co:Mo molar ratio of 2:3, which is 64% higher than that of Co-doped MoS_x , 21 times that of undoped MoS_x /graphene, and 127 times that of pure MoS_x . This study would supply an efficient strategy and a new vision for developing excellent noble-metal-free photocatalysts for photocatalytic hydrogen production.

Keywords: Amorphous molybdenum sulfide; Transitional metal; Graphene; Photocatalysis; Hydrogen Evolution

1. Introduction

Solar photocatalytic water splitting is considered a potential method to sustainably produce hydrogen energy and has been attracting huge interest over the past years

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