Incorporation of Organic Molecules into Metal Sulfides Enhances their Photocatalytic Performance

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Numerous environmental issues stem from the emission of green house gases (e.g. CO_2, CO) generated through the combustion of fossil fuels. For a sustainable environment, there is an urgent need for CO_2 reduction strategies or alternative energy sources, such as solar-hydrogen production. Among these, photocatalytic CO_2 reduction or photocatalytic H_2 production from water are considered highly promising solutions. Cadmium sulfide (CdS) has attracted significant attention as a potential photocatalyst for both CO_2 reduction and solar-hydrogen production. However, its practical application is hindered by a major limitation-rapid charge recombination. To address this issue, our research explored a novel strategy: incorporating organic molecules (e.g. phenylalanine, histidine) to the CdS nanoparticles. These organic molecules possess electron-rich aromatic ring structures that function as effective hole scavengers by capturing photo-generated holes, thereby suppressing charge recombination and enhancing photocatalytic activity. Here, the photocatalytic performances of the synthesized nanocomposites were evaluated through H_2 production from water. All modified photocatalysts exhibited higher H_2 production rates compared to pristine CdS. Among them, phenylalanine incorporated CdS showed the highest activity. Furthermore, varying the amount of photocatalyst in a reaction solution revealed that with just 1 mg of photocatalyst, the rate of H_2 production reaches to a maximum of 442 mmol/g (Fig. 1). To the best of our knowledge, this is the highest reported generation rate for CdS with a Pt co-catalyst. These findings suggest that CdS nanocomposite could be a promising approach for efficient solar-hydrogen production and CO_2 reduction.

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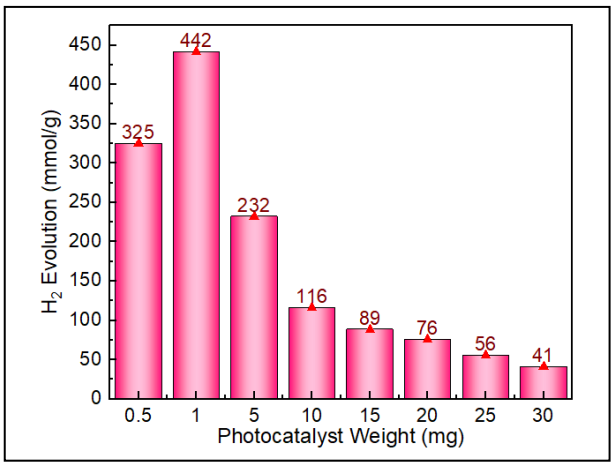

Fig. 1: Evolved H_2 vs the amount of photocatalyst.