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Solar hydrogen production using CdS-based photocatalysts supported on electrospun ZnO nanofibers

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Abstract

Unusual technologies to produce hydrogen with low carbon emissions, such as photocatalytic water splitting assisted by a semiconductor and sunlight, emerge as promising alternatives to produce sustainable energy. The photonic efficiency of this process is closely related to the photocatalyst's ability to absorb solar radiation and convert photons into molecular hydrogen, storing the energy in H-H bonds to mimic photosynthesis. Among several photocatalysts used in this process, CdS is highlighted due to its high ability to harvest visible light, the most significant portion of sunlight (SILVA et al., 2008; SOUZA et al. 2019). However, cadmium sulfide has some drawbacks, especially when considering a scale-up perspective, since it is toxic and prone to photocorrosion. Strategies to overcome these disadvantages, such as the dispersion of small amounts of CdS on the surface of non-toxic supports, like zinc oxide, have been explored. Herein, we evaluated the photocatalytic performance on hydrogen production of CdS supported on ZnO ceramic nanofibers obtained via electrospinning technique. ZnO nanofibers containing 5% Cd (Fig. 1) were submitted to a sonochemical treatment to form the CdS phase through ion exchange (O^{2-} for S^{2-}) reaction in the presence of a sulfur source (ex-situ) or during photoreaction to produce hydrogen (in-situ). The CdS/ZnO heterostructure was tested in photocatalytic hydrogen generation using a solar simulator, sulfide/sulfite pair as sacrificial reagents and Pt as a cocatalyst. The kinetic curves (Fig. 2) indicate that the ex-situ method for ion exchange (IE) results in higher photocatalytic activity since there is no consumption of sacrificial reactant for CdS formation during photoreaction. The hydrogen production rate reaches 1.5 mmol g^{-1} h^{-1}, which is much higher than that obtained with pure CdS in our previous work (SILVA et al., 2008). These results demonstrate the potential of our approach in overcoming the limitations of pure CdS.

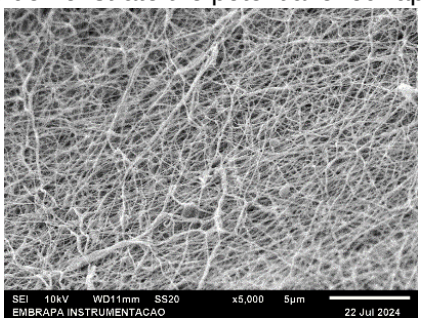

Figure 1. SEM image of CdZnO ceramic nanofibers.

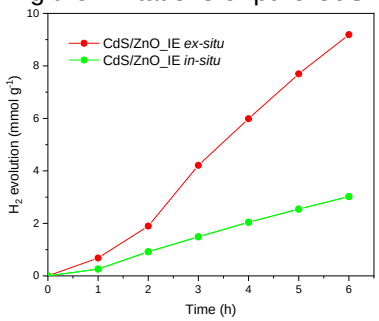

Figure 2. Kinetic curves of H_2 production.

Keywords: Photocatalysis, Hydrogen, Ceramic nanofiber

References

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SILVA et al., **J. Phys. Chem. C** (2008) 112:12069

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