Boosting Solar Hydrogen Production of Molybdenum Tungsten Sulfide-Modified Si Micropyramids by Introducing Phosphate

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Abstract

Si is regarded as a promising photocathode material for solar hydrogen evolution reaction (HER) because of its small band gap and highly negative conduction band edge. However, bare Si electrodes have high overpotential because of sluggish HER kinetics on the surface. In this study, molybdenum tungsten sulfide (MoS_2-WS_2) was decorated on Si photocathode as the co-catalyst to accelerate HER kinetics. The catalytic performance of MoS_2-WS_2 was further enhanced by introducing phosphate materials. Phosphate-modified molybdenum tungsten sulfide (PO-MoWS) was deposited on Si photoabsorbers to provide the optimal current of -15.0 mA cm^{-2} at 0 V. Joint characterizations of X-ray photoelectron and X-ray absorption spectroscopies demonstrated that the phosphate material dominantly coordinated with the WS_2 component in PO-MoWS. Moreover, this phosphate material induced a large number of sulfur vacancies in the PO-MoWS/Si electrodes that contributed to the ideal catalytic activity. Herein, TiO_2 thin film was prepared as the protective layer to improve the stability of photocathodes. The PO-MoWS/2 nm TiO_2/Si electrode maintained 83.8% of the initial photocurrent after chronoamperometric measurement was performed for 8000 s.

Keywords: Silicon Micropyramids, Molybdenum Disulfide, Tungsten Disulfide, Phosphate, Photoelectrochemical Hydrogen Production.