Hydrogen Treatment and FeOOH overlayer: Effective approaches for enhancing the photoelectrochemical water oxidation performance of bismuth vanadate thin films

The water oxidation capability of the promising photoanode bismuth vanadate (BiVO₄) is hampered by poor bulk electron transport and by high rates of charge recombination at the semiconductor/electrolyte interface. Here, we demonstrate that a dual modification of BiVO₄ by: (i) annealing in a hydrogen-containing environment and (ii) coating with FeOOH overlayer substantially enhances the water oxidation ability of BiVO₄ photoanodes. Hydrogen treated, FeOOH coated BiVO₄ photoanodes exhibit a water oxidation photocurrent density of 2.16 mA cm⁻² at 1.23 V_RHE, which is 5 times higher than for untreated BiVO₄ films. Moreover, they showed an impressive low photocurrent onset potential of −0.11 V_RHE. A stable photocurrent was observed for 1 h of water oxidation measurement at 1.23 V_RHE under 1 Sun illumination. The enhanced photocurrent of FeOOH/H:BiVO₄ photoanode is ascribed to an improved bulk charge transport, as confirmed by impedance spectroscopy measurements and Mott-Schottky analysis. The cathodic shift of the onset potential originates from a lowering of the flat band potential and from an improvement of the charge transport at the semiconductor/electrolyte interface. The dual modification strategy used here offers a simple but effective approach of improving the water oxidation performance of BiVO₄.

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