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Facile photoelectrochemical water oxidation on Co2+-adsorbed BiVO4 thin films synthesized from aqueous solutions

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Abstract

In this study, the organic solvent free 'green synthesis' of bismuth vanadate (BiVO4) has been described for its application in photoelectrochemical (PEC) water oxidation. BiVO4 thin films were successfully prepared through electrodeposition of Bi film on the FTO glass substrate from the aqueous bath containing Bi(NO3)3 in presence of K-Na-tartrate and dextrose; followed by thermo-chemical reaction with an aqueous solution of vanadium acetylacetonate (VO(acac)2). XRD & SEM-EDS analyses indicated the formation of scheelite monoclinic BiVO4 with seed-like morphology. UV–visible absorption spectra measured the band gap energy ~ 2.3 eV indicating visible-light activity of the photocatalyst and the Mott-Schottky analysis showed n-type nature of the semiconductor. Highest photocurrent of 1.3 mA cm-2 (at ~1 V vs Ag/AgCl) for water oxidation and 2 mA cm-2 (at ~0.6 V vs Ag/AgCl) for sacrificial (SO32-) oxidation were measured under 35 mW cm-2 illumination using the optimized thin film and the maximum incident photon to current conversion efficiency (IPCE) of 42% was obtained. The enhanced photocurrent in solar-assisted water oxidation is attributed to the formation of well covered and compact film with improved electrical continuity, shown by minimum charge transfer resistance. Adsorption of an optimized amount of Co2+ over the BiVO4 improves its catalytic properties towards oxygen evolution reaction by approximately 2.5 times, with lowering of charge transfer resistance of the material as measured through impedance analysis.