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Synthesis and characterization of porous $BiVO_4$ thin films: the effect of structural defects on photoelectrochemical properties

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Abstract

$BiVO_4$ thin films with thickness of ~ 1.3 μm were deposited on ITO substrate via pulsed-spray pyrolysis deposition. X-ray diffraction pattern revealed that $BiVO_4$ layers have been crystallized in tetragonal scheelite phase with average crystallite size of ~ 16 nm. According to UV-visible absorption spectra, a band gap energy of ~2.47 eV was determined for the synthesized layers. Scanning electron microscopy observations indicated that a porous $BiVO_4$ structure with average pore diameter of ~ 162 nm and worm-like fine particle diameter of ~ 208 nm has been synthesized. Oxygen vacancies have been induced into the layers via an electrochemical reduction treatment (ET). This employed process increased the surface-related capacitance by about 6 times. A double charge transport resistance and half capacitance for Helmholtz layer was determined after ET, indicating electron transfer from space charge layer to Helmholtz layer upon ET. Using electrochemical impedance spectroscopy, it was found that effective charge carrier life time inside the $BiVO_4$ thin films increased to ~25 ms which is 2-fold longer than the time before electrochemical reduction treatment.

Keywords: $BiVO_4$, porous thin film, spray pyrolysis, oxygen vacancy

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