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The effect of Cu doping on physicochemical properties of bismuth vanadate

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Bismuth vanadate (BiVO4) has attracted a lot of attention as a promising photoanode for use in the photoelectrochemical (PEC) water splitting. It posseses numerous advantageous features such as great visible light harvesting properties, band edge positions and low-cost synthesis method. The major drawback of BiVO4 is poor charge transfer properties due to the high rate of electron-hole recombination. One of the promising strategies for improving this is metal doping which efficiently boosts charge separation and increases PEC water splitting activity. Herein, we report physicochemical properties of pristine and 1%-, 2.5%- and 5%- Cu-doped BiVO4 powders, after 20h synthesis time. X-ray diffraction (XRD) study indicates that, depending on the doping level, the material exists in monoclinic or tetragonal scheelite phase, but mixed phase composition was also possible. Pure monoclinic and tetragonal phase was formed in a case of pristine and 1% doped sample. Samples doped with 2.5% and 5% of copper showed mixed phase composition. Scanning electron microscopy (SEM) reveals that sample with monoclinic phase consists of worm-like morphology, while morphology of tetragonal samples was mostly spherical.In case of samples with mixed phase a combination of prismatic and spherical shape morphology was observed. The structure was examined with Raman and Fourier Transformed Infrared (FTIR) spectroscopy. The results were in accordance with XRD study where band positions well matched the phase composition. Optical properties were characterized with UV-Vis Diffuse Reflectance Spectroscopy (DRS) and Photoluminescence (PL) spectroscopy. The band gap of pristine sample was ~2.4 eV, while band gap of sample with tetragonal phase has band gap was ~ 2.9 eV. Dual phase samples had two different band gaps that could originate from presence of both phases. From the PL spectroscopy, it can be concluded that monoclinic samples possess better recombination features than tetragonal ones. Photoelectrochemical measurements of BiVO4 samples imply that material is light sensitive and, after doping, improved performance towards oxygen evolution reaction was obtained.

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