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BiVO4 Photoanodes for Water Splitting Deposited by Reactive Magnetron Co-Sputtering: Role of Doping and Morphology for its Photoactivity

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Monoclinic bismuth vanadate (m-$BiVO_4$) has attracted attention as a photoelectrode for water splitting caused by its band gap energy of about 2.5 eV and quite high photocurrent densities of more than 4 mA/cm^2 [1].
In order to generate hydrogen by water splitting as a perspective renewable energy fuel, large-scale photoelectrolysis installations are required [2]. This needs also a large-scale deposition technology for the preparation of photoactive photoelectrodes. Therefore, in this work we used reactive co-magnetron sputtering from a Bi and a V target to deposit m-$BiVO_4$ films which were photoactive. By tailoring the Bi-to-V ratio in the films we could show that the highest photoactivity occurs under slightly V-rich deposition conditions (j_{ph} > 1.5 mA/cm^2). A significant increase of the photovoltage and the photocurrent was achieved by doping with molybdenum. At substrate temperatures above about 250 °C the films exhibit a porous morphology which is beneficial for a high photocurrent, caused by a high charge injection from the $BiVO_4$ to the electrolyte. Time-resolved microwave conductivity (TRMC) measurements to extract the charge carrier lifetime and impedance measurements for the determination of the effective surface area were used in order to elucidate the charge separation and the charge injection efficiency of our $BiVO_4$ films. The presented co-magnetron sputtering preparation route for photoactive m-$BiVO_4$ films opens new possibilities for the fabrication of large-scale devices for water splitting.
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