Investigation of Transport Mechanism in $SnO_2/BiVO_4$ Nanostructured Electrode for Water Splitting

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$BiVO_4$ has become promising candidate among the metal oxide because of its visible light absorption range and relatively negative conduction energy level at solar water splitting electrode. This advantage, however, is compromised with high hole-electron recombination property of $BiVO_4$. Although various structured designed photoelectrodes based on $BiVO_4$ have continuously enhanced the efficiency of photoelectrochemical cell, an analysis of charge transport in these structures has not been reported, especially in 3D structure. Here, we fabricate three electrode, 3D nanostructured $SnO_2/BiVO_4$, $WO_3/BiVO_4$ and $SnO_2/BiVO_4$ bilayer. We observe 22 times faster diffusion coefficient in the 3D electrodes relative to the bilayer electrode despite 8 times thicker electrode by intensity-modulated photocurrent spectroscopy (IMPS). Particularly, we observe fully trap-free transport of SnO_2 core at $BiVO_4$ side illumination. We also characterize the charge separation efficiency with effect of electron diffusion in water-splitting reaction. These results expand the scope of electron transport mechanism at different illumination direction.