Time resolved photo-driven charge transfer of oxide thin films and hybride electrodes for photoelectrochemical water splitting

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Photoelectrochemical (PEC) water splitting offers a direct path to generate hydrogen from water and sunlight using semiconductor (SC) materials. The hydrogen can be stored and utilized as sustainable fuel to satisfy the energy demand in an environmental friendly economy.[1] Hybrid devices consisting of a molecular catalyst on a solid SC absorber provide great opportunities to combine high catalytic activity regarding photocatalytic water splitting with long-term stability.[2,3] The investigation of the hybrids requires a well-known SC absorber, that is very photostable, enable a fast charge transfer to the catalyst and has a well-suited electronic bandstructure, where photo-excited hole states can capture the electrons from electrocatalytic water oxidation. One promising candidate is the oxide bismuth vanadate ($BiVO_4$) that shows high photocatalytic activity for PEC water splitting reaction.[4] We show a systematic study of the time-resolved photocatalytic activity of $BiVO_4$ thin films and similar oxide absorbers with a high functionalized surface deposited on conducting Nb-doped $SrTiO_3$ substrates. The $BiVO_4$ films were photo-electrochemically investigated under neutral aqueous conditions with a phosphate buffer electrolyte via cyclovoltammetry. Rotating ring disk electrode (RRDE) experiments in the dark and under illumination (LED 1.5 AM spectrum) allowed distinguishing between the oxygen evolution reaction and other processes such as photo-induced capacitive changes. The experiments aim to understand the electron charge transfer from water molecules into the oxide SC $BiVO_4$ surface under illumination and different applied bias. First promising steps to extend such studies to hybrid systems are pursued, where high-efficient molecular catalyst well-designed for OER are anchored on different SC surfaces.

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