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Fabrication of a heterojunction $V_2O_5/BiVO_4$ photoanode with improved photoelectrochemical performance for water splitting reaction

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Hydrogen (H_2) has featured prominently as a potential alternative and renewable energy source. To date, one of the most feasible production routes of solar H_2 generation is through the Photoelectrochemical (PEC) water splitting. In this regard, Bismuth Vanadate ($BiVO_4$) is a promising semiconductor photoelectrode material that can be used for PEC water splitting. This is owing to its low-cost, relatively narrow bandgap of 2.4 eV and favourable positioning of valance band edge that provides sufficient overpotential for water oxidation. To date, however, the practical photocurrent yield of $BiVO_4$ photoelectrode reported in the literature is far lower than its full potential due to poor photogenerated carriers separation and high bulk and surface recombination rates. The emergence of heterojunction photoelectrode design is considered to be able to address these setbacks, while providing an internal electric field for improving the photogenerated charge carriers transfer in a PEC cell setup. Thus, the main aim of this study was to fabricate a heterojunction $V_2O_5/BiVO_4$ photoanode due to the fact that V_2O_5 is the most stable form of vanadium oxide and has received intense interest due to its inherently good electrochemical and photochemical properties. The resultant heterojunction $V_2O_5/BiVO_4$ photoanode structure was characterised by using Field Emission-Scanning Electron Microscopy (FE-SEM), X-ray Diffraction (XRD), UV-visible spectroscopy and a number of PEC measurements and analysis. Through this study, it was found that the photocurrent density of a bare $BiVO_4$ photoanode increased from 0.07 to 0.40 mA/cm^2 (at 1V vs. Ag/AgCl) after the formation of a heterojunction photoanode structure with an underneath V_2O_5 layer. This is almost a 6-fold improvement in terms of photocurrent density, and this study has demonstrated the presence and role of V_2O_5 in the heterojunction structure that extends the light absorption range as well as improving the electrons mobility and effective separation of photogenerated charge carriers.

Biography

Chong Siang Yaw graduated with a BE degree in the discipline of Chemical Engineering with Honours from Monash University Malaysia. He returned to Monash University, Malaysia for Postgraduate studies under the supervision of Associate Professor Dr. Meng Nan Chong and Professor Dr. Ai Kah Soh. His research focuses on the synthesis of BiVO4-based heterojunction-tandem photoelectrodes for solar hydrogen energy conversion from PEC water splitting.

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