

Preparation of BiVO₄ Typed Photoanode for Photoelectrochemical Water Splitting

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1 Introduction

The H₂ production by water splitting using photoelectrode has attracted attention as promising energy conversion system. In particular, numerous efforts have been focused on various BiVO₄ typed photoanodes capable of utilizing a wide range of light energy (~520 nm) and achieving efficient O₂ generation through water splitting. [1] Recently, photoelectrode system capable of producing and accumulating high-value-added oxidation reagents (e.g. oxidative H₂O₂ production from H₂O) using the BiVO₄ typed photoanode has been also focused as effective utilization technique of oxidation (anode) reaction. [2-3]

The photocurrent properties (photocurrent and onset potential) in almost of BiVO₄ typed photoanodes significantly depend on the presence or absence of interlayer (underlayer) and the species. For example, a WO₃/BiVO₄ photoanode combining BiVO₄ with a WO₃ underlayer shows exceptional photoelectrochemical performance for water splitting. [1] However, detail mechanism on the photocurrent properties of BiVO₄ is still unclear about effects of underlayer.

At the beginning, we focused on the BiVO₄ on various substrates, *i.e.*, the change and difference of supported condition of BiVO₄ supported on various substrates were investigated using the X-ray absorbance fine structure (XAFS) spectra.

2 Experiment

The WO₃/BiVO₄, SnO₂/BiVO₄ and BiVO₄ on F-doped SnO₂ conductive glass (FTO) substrate prepared using metal organic decomposition (MOD) method were used as photoanode samples. The WO₃ and SnO₂ underlayer were prepared on the FTO substrate by calcination after spin coating of solution of tungsten hexachloride and tin chloride as precursors. The mixed solution (Bi:V=1:1) of commercial Bi and V solutions was coated on WO₃ and SnO₂ underlayers and the FTO substrate by same spin coating, and then the film was calcined, resulting in the formation of WO₃/BiVO₄, SnO₂/BiVO₄ and BiVO₄ photoanode. These photoanodes were characterized using XRD and the Bi L_{III}-edge XAFS (fluorescence mode).

3 Results and Discussion

BiVO₄ on these photoanodes exhibited similar diffraction patterns derived from monoclinic type BiVO₄ from result of the XRD measurement. Fig. 1 shows Bi L_{III}-edge XANES spectra of these BiVO₄ typed photoanodes. For comparison, 5 wt% BiVO₄ powder was also measured as reference sample. The XANES spectra

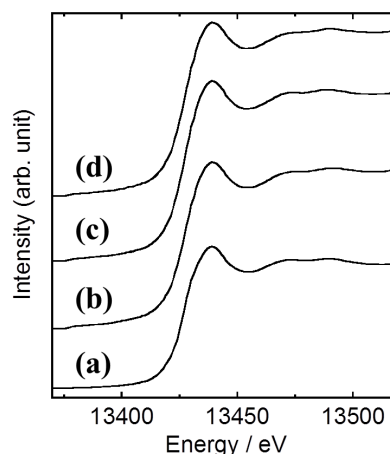


Fig. 1: Bi L_{III}-edge XANES spectra of (a) 5 wt% BiVO₄ powder (reference), (b) BiVO₄, (c) WO₃/BiVO₄ and (d) SnO₂/BiVO₄.

of all samples were similar to that of the reference BiVO₄ powder, and few energy shift was also observed. Interestingly, although the WO₃/BiVO₄ photoanode exhibited particularly-excellent photocurrent and onset potential in electrolyte of KHCO₃ aqueous solution compared to BiVO₄ photoanode without underlayer, little change of selectivity (Faraday efficiency) of oxidative H₂O₂ production using H₂O as raw material was also confirmed in the BiVO₄ and WO₃/BiVO₄ photoanodes [3]. These results indicate that these BiVO₄ particles prepared using the MOD method possess similar valence and coordination structure despite different substrates, and these specific phenomena on photocurrent properties and product selectivity by species of substrates may derive from interface between the BiVO₄ and underlayer or FTO substrate. More detail tracking for mechanism elucidation are currently under investigation.

References

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