Semiconductor Nanostructure Engineering for Solar Hydrogen Production

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Photoelecctrochemcial water splitting provides an attractive method to convert the abundant solar energy into sustainable and clean hydrogen energy. The greatest challenge is how to develop efficient and stable photoelectrodes, including photoanodes and photocathodes. Comparing to the widely studied photoanodes, the photocathodes have been paid less attention due to the scarcity of suitable semiconductor candidates. Some available photocathodes derived from p-type semiconductors such as single crystal Si, chalcogenide (e.g., CuInGaSe) are either not stable or too expensive to realize large scale application. Herein, a promising p-type semiconductor, $CuBi_2O_4$, has been used to fabricate efficient photocathode. Moreover, combining the $CuBi_2O_4$ photocathode with well-developed $BiVO_4$ photoanode, it is able to demonstrate unbiased sunlight-driven solar water splitting.

$CuBi_2O_4$ electrodes were prepared with electrodeposited BiOI and copper acetylacetonate as precusor after heating in air at 450°C for 4 hours. The $CuBi_2O_4$ photocathode possesses a porous nano-branch strucutre and showed a photocurrent of -0.95 mA/cm^2 at 0.21 V_{RHE} along with an onset potential at 1.1 V_{RHE} in Sodium Phosphate (~pH 7) electrolyte. With the presence of electron scavengers, the photocurrent was further enhanced to -2.4 mA/cm^2 at 0.48 V_{RHE}. The incident photon-to-current efficiency showed a threshold at ca. 620 nm, suggesting a broad light harvesting range of the $CuBi_2O_4$ photocathode. Furthermore, the large onset potential of $CuBi_2O_4$ photocathode makes it feasible to realize unbiased photoelectrode water splitting when combined with suitable photoanode, such as $BiVO_4$.

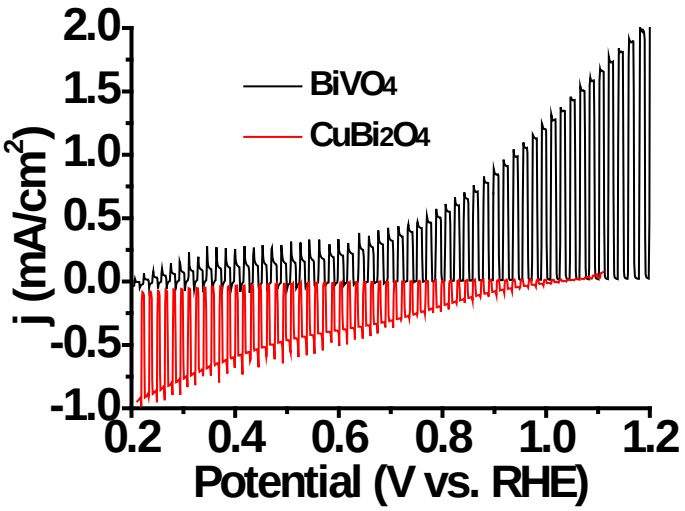


Figure 1. The photoresponse of $CuBi_2O_4$ and $BiVO_4$ under chopped light.

In conclusion, we have developed a new method for fabricating the state-of-the-art $CuBi_2O_4$ photocathode. Further combining with $BiVO_4$ photoanode, it can achieve efficient unbiased water splitting.

Biography



Sabiha Akter Monny is a PhD student at the University of Queensland. She specialises in renewable energy, energy conversion, and nanomaterials. Her research focuses on developing photocatalysts using semiconductor nanomaterials for photoelectrochemical energy conversion.

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