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The improved photoelectrochemical stability of a $CuBi_2O_4$ photocathode provided by graphene quantum dots cocatalysts

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Among several semiconductors that have recently surfaced as photocatalysts for the sunlight-driven water splitting, copper bismuth oxide ($CuBi_2O_4$) has been considered one of the most promising. It is a cheap and non-toxic material that possesses improved structural and photochemical features compared to some of the most employed photocatalysts.[1] These features include smaller band gap, longer charge carriers diffusion and adequate valence band energy for the water reduction semi-reaction. Nonetheless, some drastic limitations still hinder the performance of $CuBi_2O_4$, such as high electron transfer resistance at the solid/liquid interface and structural instability under irradiation. To circumvent those limitations, we loaded the surface of the $CuBi_2O_4$ thin films with graphene quantum dots (GQD) as cocatalysts to promote rapid electron transfer pathway and to inhibit photocorrosion.[2] In this work, visible-light absorbing phase-pure $CuBi_2O_4$ ultrathin films, with band gap of 2.0 eV, was obtained through an electrodeposition method. Graphene quantum dots were synthesized through a hydrothermal route using pyrene as the precursor and loaded onto the surface of $CuBi_2O_4$ through a spin coating method. Photoelectrochemical tests in a Na_2SO_4 electrolyte (pH 6.5) of the pristine $CuBi_2O_4$ ultrathin films resulted in a photocurrent density of -0.116 mA cm^{-2} at -0.3 $V_{Ag/AgCl}$. After the surface modification with GQD, the photocurrent density changed to -0.102 mA cm^{-2} at -0.3 $V_{Ag/AgCl}$ (Fig. 1a). However, water reduction overpotential reduced and the photocurrent stability showed an improvement, as it retained 79 % of the initial photocurrent density over the course of 600 s under simulated sun light irradiation (AM 1.5G, 100 mW cm^{-2}). The bare photoelectrode retained only 61 % of the initial photocurrent density (Fig. 1b). Future work involves the optimization of the GQD loading and post-thermal treatment under inert atmosphere to further improve the charge transfer rates, which still hinder the performance of our modified photoelectrode, according to our results.

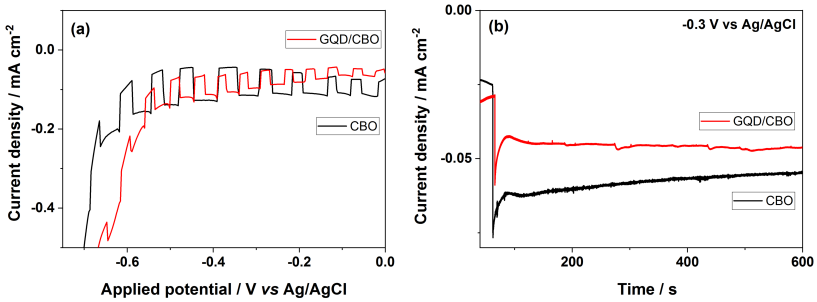

Figure 1. Photoelectrochemical (a) and chronoamperometry (b) measurements of $CuBi_2O_4$ and GQD-modified $CuBi_2O_4$ electrodes in Na_2SO_4 electrolyte under a simulated sunlight irradiation.

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References

[1] N. T. Hahn *et al.*, J. Phys. Chem. C, **116**, 6459 (2012).
[2] M. A. Melo and F. E. Osterloh, ACS Appl. Mater. Interfaces, **10**, 27195 (2018).