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Supporting Information

$H_3PW_{12}O_{40}/Co_3O_4$-Cu_2S as a low-cost counter electrode catalyst for quantum dots-sensitized solar cells

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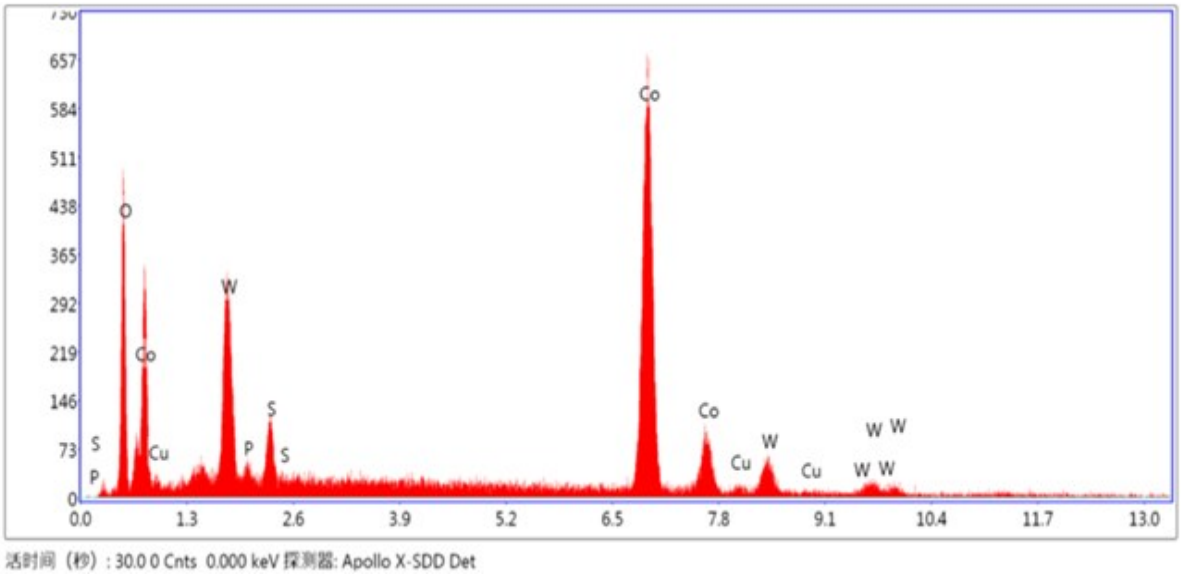

Fig. S1 EDX diagram of PW_{12}/ Co_3O_4-Cu_2S film.

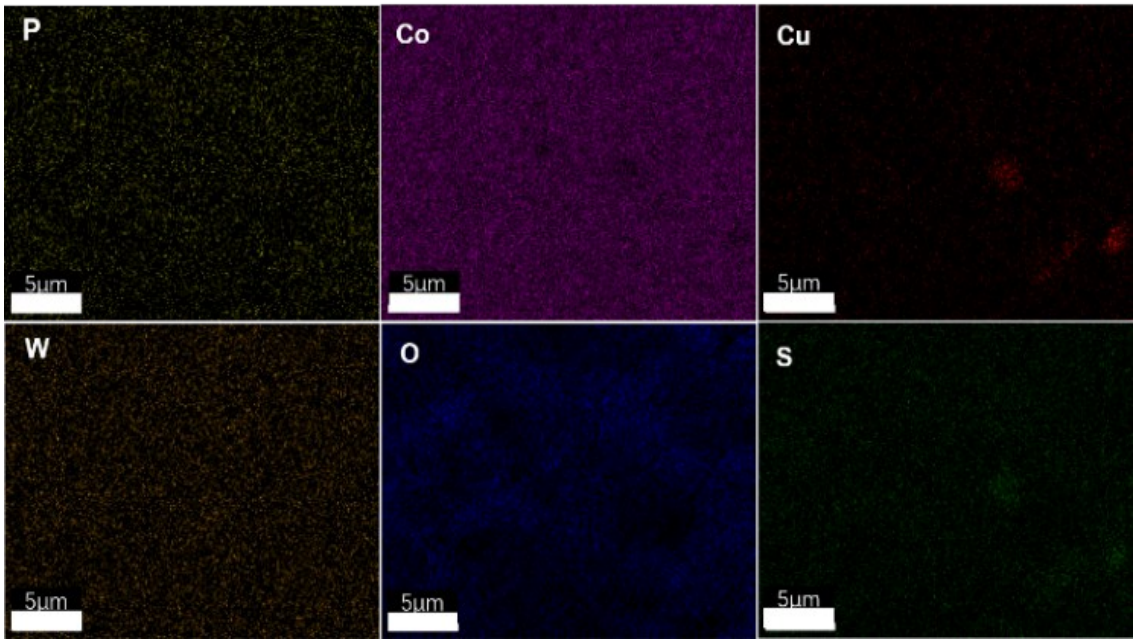

Fig. S2 EDX elemental mappings P, W, Co, O, Cu and S in PW_{12}/Co_3O_4-Cu_2S film.

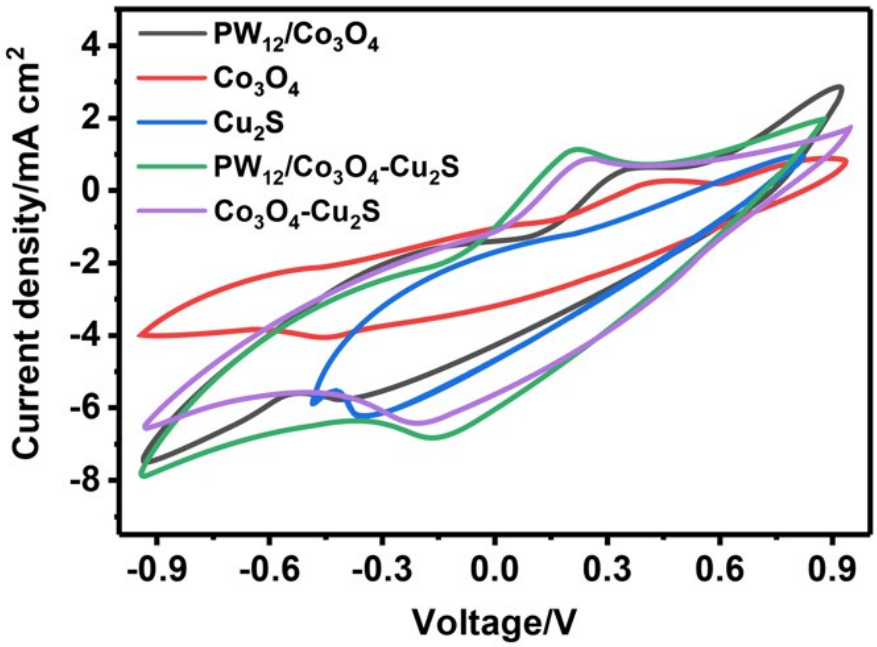

Fig. S3. CV curves of different counter electrodes in the three-electrode system.

To evaluate the electrocatalytic activities, the cyclic voltammetry (CV) measurement were performed over Co_3O_4, PW_{12}/Co_3O_4, Cu_2S, Co_3O_4-Cu_2S, PW_{12}/Co_3O_4-Cu_2S counter electrodes, respectively (Fig. S3). The CV curves could indicate the catalytic reaction at the interface of the CE/electrolyte. The reduction of S_x^{2-} ions lead to the negative currents, while the positive currents result from the oxidation of S^{2-} ions. Furthermore, the reduction peak current is the most important, which largely reflects the catalytic ability of CE for S_x^{2}-reduction in the QDSSCs.[1] Peak to peak separation (Epp) is also crucial parameters for evaluating the catalytic performance of the counter electrode.[2] From the curves, compared with other counter electrodes, the composite PW_{12}/Co_3O_4-Cu_2S counter electrodes have higher peak current and minimum Epp, suggesting that the composite counter electrodes have better electrocatalytic performance.

Reference

1. M. Yeh, L. Lin, C. Lee, C. Chou, K. Tsai and J. Ho, High performance CdS quantum-dot-sensitized solar cells with Ti-based ceramic materials as catalysts on the counter electrode, *Journal of Power Sources*, 2013, **237**, 141-148.
2. L. Chen, W. Chen and E. Wang, Graphene with cobalt oxide and tungsten carbide as a low-cost counter electrode catalyst applied in Pt-free dye-sensitized solar cells, *Journal of Power Sources*, 2018, **380**, 18-25.