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Direct Oxidation Synthesis for a Dual-Layer Silver/Silver Orthophosphate with Controllable Tetrahedral Structure as an Active Photoanode for Solar-Driven Photoelectrochemical Water Splitting

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Abstract : The vast increase in global energy demand, coupled with the growing concerns on environmental issues, has triggered the search for cleaner alternative energy sources. In view of this, the photoelectrochemical (PEC) water splitting offers a sustainable hydrogen (H2) production route that only requires solar energy, water, and PEC system operating in an ambient environment. However, the current advancement of PEC water splitting technologies is still far from the commercialization benchmark indicated by the solar-to-H2 (STH) efficiency of at least 10 %. This is largely due to the shortcomings of photoelectrodes used in the PEC system, such as the rapid recombination of photogenerated charge carriers and limited photo-responsiveness in the visible-light spectrum. Silver orthophosphate (Ag3PO4) possesses many desirable intrinsic properties for the fabrication into photoanode used in PEC systems, such as narrow bandgap of 2.4 eV and low valence band (VB) position. Hence, in this study, a highly efficient Ag3PO4-based photoanode was synthesized and characterized. The surface of the Ag foil substrate was directly oxidized to fabricate a top layer composed of {111}-bound Ag3PO4 tetrahedrons layer with a porous structure, forming the dual-layer Ag/Ag3PO4 photoanode. Furthermore, the key synthesis parameters were systematically investigated by varying the concentration ratio of capping agent-to-precursor (R), the volume ratio of hydrogen peroxide (H2O2)-to-water, and reaction period. Results showed that the optimized dual-layer Ag/Ag3PO4 photoanode achieved a photocurrent density as high as 4.19 mA/cm2 at 1 V vs. Ag/AgCl for the R-value of 4, the volume ratio of H2O2-to-water of 3:5 and 20 h reaction period. The current work provides a solid foundation for further nanoarchitecture modification strategies on Ag3PO4-based photoanodes for more efficient PEC water splitting applications. This piece of information needs to be backed up by evidence; therefore, you need to provide a reference. As the abstract should be self-contained, all information requiring a reference should be removed. This is a fact known to the area of research, and not necessarily required a reference to support.

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