$ZnFe_2O_4$ Dendrite-SnO_2 Helix 3D Hetero-Structure Photoanodes for Enhanced Photoelectrochemical Water Splitting

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$ZnFe_2O_4$ is a promising photoanode material for photoelectrochemical (PEC) water splitting due to its narrow bandgap and suitable band position for water oxidation. However, its performance is limited because it has its indirect bandgap and poor charge transport properties. Helix structured SnO_2 is employed as an electron transport layer for efficient utilization of long-wavelength photons and enhanced charge transport. Thus, helix SnO_2 forms a heterojunction with $ZnFe_2O_4$ dendrite to scatter light and allow photons to travel longer distances for effective attenuation. As a result, $ZnFe_2O_4$/helix SnO_2 shows a seven-fold increase in IPCE at 530 nm relative to unmodified $ZnFe_2O_4$. With further modifications with a TiO_2 passivation layer and a $NiFeO_x$ co-catalyst, $NiFeO_x$/TiO_2/ $ZnFe_2O_4$/helix SnO_2 photoanode records a water oxidation photocurrent of 0.94 mA/cm^2 at 1.23 V_{RHE} under simulated 1 sun conditions, which is comparable to the performance of reported state-of-the-art of $ZnFe_2O_4$ photoanodes.