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A highly efficient photoanode for enhancing degradation of the azo dye and electricity generation of dual-photoelectrode photocatalytic fuel cell

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Discharging organic matters into water bodies directly not only causes serious environment pollution but also wastes energy source. A visible light driven photocatalytic fuel cell (PFC) system comprised of photoanode and photocathode/cathode was established for organic matters decomposition and electricity generation. Under visible illumination, the PFC system is driven by mismatch Fermi levels between photoelectrodes with an interior bias can be produced. The photogenerated electrons of photoanode were excited and transferred to combine with photogenerated holes of photocathode through the external circuit. Meanwhile, the photoanode provides a negative bias for photocathode; in contrast, the photocathode provides a positive bias for photoanode then generates electricity. At the same time, the organic matters decomposed by photogenerated holes stay in photoanode. In this study, we investigated the photoanode modification by Ni-Fe layered double hydroxide (NiFe-LDH) for enhancing the photocatalytic fuel cell (PFC) using Cu_2O/Cu photocathode. The experimental results show that the NiFe-LDH/$BiVO_4$ photoanode obtains a photocurrent density of 0.620 mA/cm^2 at 1 V vs. SCE in 0.5 M sodium sulfate (Na_2SO_4) as the electrolyte exposed under AM 1.5 solar light. The highest short-circuit current, open-circuit voltage and maximum power density of the NiFe-LDH/$BiVO_4$-Cu_2O/CuPFC are 0.251 mA/cm^2, 0.742 V, 0.186 mW/cm^2, respectively. For tests using methylene blue and Na_2SO_4 as the model organic substrate and supporting electrolyte, respectively, NiFe-LDH/$BiVO_4$-Cu_2O/CuPFC achieves a degradation efficiency of 81%. The NiFe-LDH/$BiVO_4$ photoanode effectively improves the performance of the PFC in terms of wastewater degradation rate and electricity generation. The experimental results show that the proposed heterojunction photoanode can decrease the interface recombination at the NiFe-LDH/$BiVO_4$ junction and extend the spectrum of visible light absorption. It is attributed to enhanced connectivity of $BiVO_4$ particles by the NiFe-LDH layer to avoid loss of the photoexcited electrons.

Biography

He Yun is a final year PhD student from Professor Michael Leung's group, City University of Hong Kong. She is doing her research on photoelectrochemical system and photocatalytic fuel cell.

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