High-performance and stable photoelectrochemical water splitting cell with organic-photoactive-layer-based photoanode

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Considering their superior charge-transfer characteristics, easy tunability of energy levels, and low production cost, organic semiconductors are an ideal for photoelectrochemical (PEC) hydrogen production. However, organic-semiconductor-based photoelectrodes have not been extensively explored for PEC water-splitting because of their low stability in water. Herein, we report high-performance and stable organic-semiconductors photoanodes consisting of p-type polymers and n-type non-fullerene materials, which are passivated using nickel foils, GaIn eutectic, and layered double hydroxides as model materials. We achieve a photocurrent density of 15.1 mA cm^{-2} at 1.23 V vs. reversible hydrogen electrode (RHE) with an onset potential of 0.55 V vs. RHE and a record high half-cell solar-to-hydrogen conversion efficiency of 4.33% under AM 1.5G solar simulated light, which is the highest value among those of all reported photoanodes. After conducting the stability test at 1.3 V vs. RHE for 10 h, 90% of the initial photocurrent density is retained, whereas the photoactive layer without passivation lost its activity within a few minutes.