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Solar-driven reactors for CO_2 conversion using gas diffusion electrodes

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The search for sustainable pathways for conversion of CO_2 to value-added chemicals progressively interested researchers over the last decade. Our research group has been investigating reactors to promote solar-driven photoelectrochemical (PEC) CO_2 reduction reaction (CO_2RR). The initial results were obtained using a PEC H-cell assembled with a photo-responsive gas diffusion electrode (GDE) prepared by deposition of Cu_2WO_4 particles (a p-type semiconductor) on carbon paper placed between two titanium mesh. As photoanode, a Ti foil was covered with a film of $BiVO_4$ modified with Ni-Fe hydroxides, a well-known n-type semiconductor with remarkable activity for oxygen evolution reaction (OER). The Ti|$BiVO_4$|FeOOH|NiOOH photoanode (9.0 cm^2) was associated with the GDE|Cu_2WO_4|Ti-mesh photocathode (7.5 cm^2) under CO_2 flow in a PEC H-cell, using $NaHCO_3$ aqueous solution as electrolyte (ca. 150 mL). Under irradiation, with no external bias, this PEC-reactor exhibited an open circuit potential of 0.4 V and a short-circuit photocurrent of ca. 0.7 mA, and continuously sustained OER and CO_2RR. The main liquid product generated from CO_2RR in this system was ethanol with a Faradaic Efficiency of (14 ± 3) %. Using another reactor with electrolyte flow, we are also evaluating the GDE|Cu_2WO_4 performance and the CO_2RR products selectivity. Recently, we are also investigating the CO_2RR using another PEC reactor that was 3-D printed with ABS (Acrylonitrile Butadiene Styrene) filament. Thus, since the reactors configuration should fill requirements such as light transmittance, gas permeability, mass exchange, and suitable electrical contacts, this configuration is a remarkable challenge to achieve sustainable pathways for CO_2 conversion.

Keywords: Photoelectrochemical reactors, CO_2RR, solar-driven, gas diffusion electrode.

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