Hetero-structure CdSeCuFe2O4 as an efficient visible light active photocatalyst for photoelectrochemical reduction of CO2 to methanol

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ABSTRACT

In the present paper, hetero-structured CdS–CuFe2O4 nanocomposite was synthesized by a facial method to convert CO2 to methanol in the photoelectrochemical (PEC) system. The synthesized catalysts were characterised by XRD, Raman spectroscopy, TEM, FESEM, EDX, XPS, UV–vis and PL spectroscopy. The CdS–CuFe2O4 photocatalyst showed ~6 times higher photocurrent compared to the CuFe2O4 at −0.35 V vs. NHE of bias potential under CO2 environment as revealed by chronoamperometry results. Incident photon to current efficiency (IPCE) for CuFe2O4 and CdS–CuFe2O4 at 470 nm were found as 7.28 and 12.09%, respectively which clearly indicates the proficiency of CdS–CuFe2O4 heterojunction to absorb the visible light resulting in e−/h+ generation and the charge transfer during PEC CO2 reduction. Products in aqueous and gas phases were analysed which confirmed the selective production of methanol with trace amounts of H2 and CO. The CdS–CuFe2O4 catalyst demonstrated 72% and 16.9% of Faradaic and quantum efficiencies, respectively in terms of methanol production where a methanol yield of 23.80 μmole/Lcm2 was achieved in CO2 saturated aqueous solution of NaHCO3 (0.1 M). Detailed investigation revealed that the conduction band (CB) of the CdS in the heterojunction catalyst could act as a CO2 reduction site by trapping photogenerated electrons from the highly photosensitive CuFe2O4 while the water oxidation could take place at the valance band (VB) of CuFe2O4..

KEYWORDS

Photoelectrochemical; CO2 reduction; Hetero-structure CdS–CuFe2O4; Methanol

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