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Polypyrrole-promoted rGO-MoS2 nanocomposites for enhanced photocatalytic conversion of CO2 and H2O to CO, CH4, and H2 products

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Abstract

Advanced functionalized nanomaterials are indispensable for the efficient production of solar fuels *via* the reduction of CO_2 under solar light. This approach simultaneously addresses two major issues: (a) global warming due to anthropogenic CO_2 production and (b) the ongoing energy crisis. Owing to their high catalytic activity and visible-light absorption, MoS_2 has recently emerged as a suitable candidate for the photocatalytic production of solar fuels from water splitting and CO_2 reduction. However, it currently shows poor conversion efficiency because of low adsorption of reactant gases, fast radiative recombination, and low chemical stability; these factors limit their practical applicability. In this work, CO_2 photoreduction and H_2 production were enhanced by integrating photoabsorber MoS_2 and N-containing conducting polymer polypyrrole (PPy) on reduced graphene oxide (rGO). rGO–MoS_2/PPy nanocomposites with various amounts of PPy were fabricated and morphologically, structurally, and optically characterized using several techniques. The optimal rGO–MoS_2/PPy nanocomposite was found to exhibit a remarkable production of CO (3.95 μmol g^{-1} h^{-1}), CH_4 (1.50 μmol g^{-1} h^{-1}), and H_2 (4.19 μmol g^{-1} h^{-1}) in the photocatalytic reduction of CO_2 in an aqueous suspension under simulated sunlight. The enhanced photocatalytic performance of the nanocomposites was attributed to the beneficial combination of the rGO skeleton, MoS_2 nanosheets, and *in situ* polymerized conductive PPy; this effectively promoted charge transfer, delayed recombination, improved light absorption, and CO_2 adsorption. In summary, this study describes an inexpensive non-noble metal photocatalyst with three components for the efficient photoreduction of CO_2 into clean solar fuels.