Abstract

The synthesis, characterization and photocatalytic performance study of bismuth-based reduced graphene oxide (rGO) supported photocatalysts for selective photo-reduction of CO_2 to renewable fuel are described in the thesis. In particular, two unresolved research gaps or challenges are addressed in this thesis: (a) achievement of selective photocatalytic CO_2 reduction for fuel generation utilizing visible light from the solar spectrum; (b) enhancement in yield of CO_2-reduced selective fuel for commercialization. In the context of alternative renewable fuels like methanol (CH_3OH), ethanol (C_2H_5OH), and formic acid (HCOOH) generation, the photocatalytic CO_2 reduction system with the appropriate light source giving 1 sun light intensity is optimized. Photocatalyts, including rGO-supported Bi_2S_3, Bi_2MoO_6, and $BiVO_4$-based composites, are synthesized by hydrothermal treatment. To achieve the highest yield of selective fuel generation from photocatalytic CO_2 reduction process, rGO/Bi_2S_3 and rGO/Bi_2MoO_6 photocatalyts are modified by the optimal amount of Cu doping, and rGO/$BiVO_4$ photocatalyts are modified by the optimal amount of N-doping. The optimal amount of Cu and N doping in an rGO-supported bismuth-based photocatalyst actually manifests the smallest band gap, the lowest resistance of charge transfer, the lowest recombination rate of electron-hole pair, and the highest absorption edge-red shift for achieving the highest yield of selective photocatalytic CO_2-reduced fuel generation. In 1% Cu doped 1D-Bi_2S_3/rGO photocatalyst, 100% selective methanol (CH_3OH) with the highest yield of 719 μmol $g_{cat.}^{-1}$ h^{-1} as photocatalytic CO_2 reduced product is achieved. The 2%Cu-(2D) Bi_2MoO_6 nanoribbon/rGO composite exhibits a 100% selective ethanol (C_2H_5OH) with the evolution rate of 133.10 μmol $g_{cat.}^{-1}$ h^{-1}. It is also found that the 1.5% N-(2.5%)rGO/$BiVO_4$ photocatalyst is the active photocatalyst for increased photocatalytic reduction of CO_2 to selective formic acid (HCOOH), with the productivity of 592.80 μmol $g_{cat.}^{-1}$ h^{-1}.