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Enhancing the CO2 Photoreduction of SnFe2O4 by Surface Modification Through Acid Treatment and Au Deposition

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Abstract : The synergy effect of surface modifications using the acid treatment and noble metal (Au) deposition on the efficiency of SnFe2O4 (SFO) nano-octahedron photocatalyst has been investigated. Inorganic acids (H2SO4 and HNO3) were employed to compare the effects of different acids. It has been found that after corrosion treatment using H2SO4 and deposition of Au nanoparticles, SnFe2O4 nano-octahedron (Au-S-SFO) showed significantly enhanced photocatalytic activity under simulated light irradiation. Au-S-SFO was characterized by XRD, XPS, EDS, FTIR, Uv-vis-DRS, SEM, PL, and EIS analysis. The mechanism for CO2 reduction was investigated by scavenger tests. The stability of Au-S-SFO was confirmed by continuously repeated tests followed by XRD analysis. The surface corrosion treatment of SFO octahedron with H2SO4 could produce hydroxyl group (-OH) and sulfonic acid group (-SO3H) as reaction sites. These active sites not only enhanced the Au nanoparticles deposition to the acid treated SFO surface but also acted as the Brønsted acid sites that enhance the water adsorption and provide protons for CTC degradation and CO2 reduction. These effects improved the carrier separation and transfer efficiency. In addition, the photocatalytic efficiency was further enhanced by the surface plasmon resonance (SPR) effect of Au nanoparticles deposited on the surface of acid-treated SFO. As a result of the synergy of both acid treatment and SPR effect from the Au NPs, Au-S-SFO exhibited the highest CO2 reduction activity with 2.81, 1.92, and 2.69 times higher evolution rates for CO, CH4, and H2, respectively than that of pure SFO.

Keywords : surface modification, CO2 reduction, Au deposition, Gas-liquid interfacial plasma
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