Photocatalytic Hydrogen Production under Visible Light over Magnesium Ferrite

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ABSTRACT

Magnesium ferrite ($MgFe_2O_4$) was synthesized by the hydrothermal technique and was found to be an active photocatalyst for hydrogen production from water under visible light. The structural, morphological, and optical properties of the material were characterized by powder XRD, SEM, TEM, and UV-Vis diffuse reflectance spectroscopy. Iron and magnesium aqueous nitrate solutions were used as precursors under hydrothermal conditions of 200 °C for 3.5 h. $MgFe_2O_4$ photocatalytic activity towards the H_2 production was determined by gas chromatography, using a batch-type quartz photoreactor and irradiated using a 250 W mercury lamp. XRD results from the synthesized sample found the $MgFe_2O_4$ crystalline structure. The optical properties revealed semiconducting properties with a band gap energy of 1.9 eV (653nm) showing an efficient visible light absorption. SEM images found particles with a morphology in the form of agglomerates composed of hemispherical particles, while TEM images revealed particles with an average of 9.3 nm in size. Furthermore, the solid exhibited a high photoactivity toward the reduction of water, which is attributed to the efficient separation and transportation of the photogenerated charge carriers. This ferrite material exhibited a production of 650 μmol $H_2/g_{catalyst}$ over an irradiation period of 8 h, thus exceeding the H_2 generation obtained by TiO_2, which was of 14 μmol $H_2/g_{catalyst}$. This increase in H_2 production is attributed to the fact that $MgFe_2O_4$ exhibits a band gap, which is activated under the visible light range.

Keywords: Hydrogen production, $MgFe_2O_4$, Water splitting