Synthesis Method Effect of $CoFe_2O_4$ on its Photocatalytic Properties for H_2 Production from Water and Visible Light

Y. Ortega-López[1], J. Salinas Gutiérrez[1], V. Guzmán Velderrain[1], A. López Ortiz[1], V. Collins Martínez[1*]

[1]Centro de Investigación en Materiales Avanzados S. C., Laboratorio Nacional de Nanotecnología, Depto. de Materiales Nanoestructurados, Miguel de Cervantes 120, C. P. 31109, Chihuahua, Chih. México
. Tel: +52 (614)439 11 29 *e mail: virginia.collins@cimav.edu.mx

ABSTRACT

More efficient materials, which work under the visible light spectrum (energy bandgap from 1.5 to 3.0 eV) are the trends for today's new photocatalysts in the field of hydrogen production. Within this criteria, some transition metal ferrites are ideal. Since, the development of a ferrite-based photocatalytic material will help to address the need for a stable photocatalysts, activated under visible light and with high application potential due to their low cost. In particular, this paper reports cobalt ferrite ($CoFe_2O_4$) as a photocatalyst for hydrogen production, activated under visible light. A comparison between two methods of synthesis; chemical co-precipitation (CP) and milling ball (BM) is presented based on its photocatalytic properties. Furthermore, the influence of the synthesis method over the observed activity is presented. Characterization of $CoFe_2O_4$ was performed by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), BET surface area, UV-Vis spectroscopy and water adsorption/desorption tests. Evaluation of the photocatalytic activity under visible light was followed by gas chromatography. Results indicate that crystalline materials with nanometer sizes were obtained (dp < 25nm). BET areas of 21 and 4 m^2/g and band gap energies of 1.3 eV and 1 eV were found for $CoFe_2O_4$ synthesized by CP and BM techniques, respectively. Water adsorption tests shown an adsorption capacity of 39 for the CP and only 0.3 mg-adsorbed-H_2O/g-catalyst for the BM synthesis. The substantial decrease in surface area and adsorption capacity of the ferrite obtained by BM is attributed to a possible sintering process that the material undergoes during its synthesis. Photocatalytic activity results showed better yields for $CoFe_2O_4$ obtained through the CP synthesis. These results are associated with a higher water absorption capacity and greater surface area of this ferrite, properties that the CP synthesis method, which is based on soft and wet chemistry, provides to the material.

Keywords: cobalt ferrite, visible light photocatalyst, hydrogen producton.

Sociedad Mexicana del Hidrógeno A. C.
Mexican Hydrogen Society

CONACYT

ITC