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Synthesis and Characterization of $CaFe_2O_4$ Spinel as Photocatalyst for Hydrogen Production

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ABSTRACT

$CaFe_2O_4$ photocatalyst was successfully synthesized by nitrate route using $La(NO_3)_3.6H2O$, and $Fe(NO_3)_3.9H_2O$ as metal ion. The material was characterized by various techniques including TGA-DT, XRD, FT-IR, UV-visible, SEM-EDX, XPS and electrochemical analysis. The photocatalytic activity of the $CaFe_2O_4$ was successfully tested for hydrogen production H_2 under visible light irradiation. A pure phase of $CaFe_2O_4$ is obtained at 850 C° with an orthorhombic structure and an average crystallite size of 31 nm. The photocatalytic activity reveals an optimal H_2 production of 189 µmol within 30 min at 50°C in NaOH medium and a catalyst mass of 100 mg, under visible light irradiation.

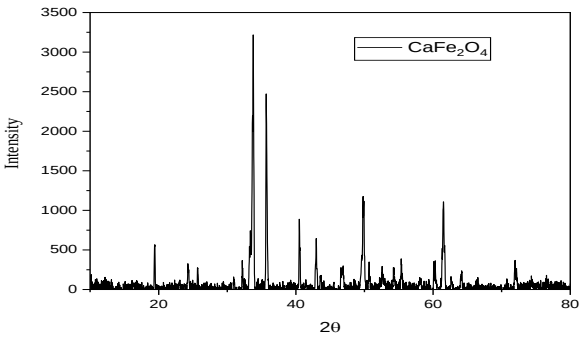

Figure 1: The diffractogram of $LaCoO_3$ synthetized by nitrate route.

Keywords: $CaFe_2O_4$, hydrogen production, photocatalyst, nitrate rout

1. Introduction

Today, global consumption of fossil fuels for energy production has increased rapidly, causing an alarming rise in global temperature due to the generation of greenhouse gases [1-2]. Green hydrogen is considered one of the most important clean renewable energies compared to conventional energies [3]. Photocatalyst water splitting to produce hydrogen is one of the most important renewable energy sources in a promising and inexpensive way [4].

2. Experimental

The photocatalysis was performed in a double-walled Pyrex reactor (200 mL) hermetically closed and thermostated at 50 (± 1°C). The activity was assessed through H_2 released under visible light. Three LED lamps (3×13 W, 13 mW cm^{-2}) were used to activate the photocatalyst in the whole suspension, a water filter was used to eliminate the heating effect, and the light intensity and uniformity were controlled by a digital flux meter.

3. Results and Discussion

XRD analysis of the prepared powder shows the presence of a pure perovskite phase, exhibiting an orthorhombic structure with an average crystallite size of 31 nm (Space Group: Pbnm, N° 62), agreement with JCPDS Card (JCPDS card No. 01-074-2136) with refined lattice constant a = 10,66,b= 9,20, c= 5.377 Å, the spinel showed 138.38 µmol hydrogen evolution at pH~7 under visible light irradiation, significant increases 189.31 µmol recorded in pH~12 under the same condition after 30min.

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4. Conclusions

This work devoted to prepared $CaFe_2O_4$ spinel by nitrate method was characterized physically and electrochemically and applied for the hydrogen production under visible light, XRD analysis confirmed the formation of a pure phase at ~ 850°C with particle dimension of ~31 nm, $CaFe_2O_4$ showed high activity H_2 production of 189.31 µmol in NaOH electrolyte (pH ~ 12) after 30min.

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