Keywords

Photocatalyst; Flow reactor; Nitrobenzene

Acknowledgements

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P35 Synthesis and characterization of MgAlFe-CO_3 LDH-based photocatalysts for NOx gases remediation

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Extended Abstract

Summary

This study examines the effectiveness of Layered Double Hydroxides (LDHs), prepared by “Aqueous Miscible Organic Solvent Treatment”, as photocatalysts for removing atmospheric pollutants, particularly NO_x gases. The study specifically explores the influence of the Fe^{3+} cation on the photocatalytic efficiency of MgAl-CO_3 LDH systems. The results demonstrate that thus prepared LDHs are highly efficient for this application.

Background

Nowadays, major urban areas are dealing with significant pollution problems caused by human activity. Nitrogen oxides (NO and NO_2, collectively denominated as NO_x) are one of the most common primary air pollutants in the atmosphere. Many cities frequently registered NO_x pollution levels above the annual limit value set by the European Union. It is important to note that these levels can have adverse effects on the environment, ecosystems, and public health [1, 2].

In recent decades, photocatalysis has become a popular advanced method for decontamination. Layered Double Hydroxides (LDHs) are recognized as a promising photocatalyst [3] for the oxidative conversion of NO_x gases (De-NO_x action). These materials are represented by the general formula $[M^{II}_{1-x}M^{III}_x(OH)_2]^{x+}\cdot A^{n-}_{x/n}\cdot mH_2O$, where M^{II} and M^{III} are metal cations, and the interlayer anions A^{n-} can be various inorganic or organic anions. LDHs are easy to synthesise, and their versatile composition allows them to develop photocatalytic activity in a wide range of the solar spectrum.

This study assesses the efficacy of substituting Fe^{3+} in MgAl-CO_3 systems for photocatalytic NO_x gases removal. The AMOST (Aqueous Miscible Organic Solvent Treatment) method enables the exfoliation of LDHs into 2D layers, which can reduce their particle size and increase their specific surface area [4], to improve the efficiency of the photocatalyst.

Methodology

LDHs were synthesised by the co-precipitation method. A solution of $MgCl_2$, $AlCl_3$, and $FeCl_3$ (with M^{II}/M^{III} = 2; 3) was added to a solution of Na_2CO_3. The pH was monitored and maintained at 10 by adding a 4.0 M NaOH solution. The dispersion was then filtered and washed with water until a neutral pH was achieved. Next, the collected wet product underwent AMOST method to produce the delamination of particles [5]. The wet solid was washed with acetone, filtered, and then dispersed in acetone while it was stirring for 4 hours. The product was filtered again, washed, and dried in an oven at 60 °C.

under an artificial sunlight source. The photoreactor was supplied with a mixture of synthetic air and pure NO as a pollutant, and the concentration of NO and NO_2 gases at the exit were determined by a chemiluminescence analyser.

Results and Discussion

The XRD analysis revealed a typical pattern of an LDH with carbonate anion in the interlayer, with crystallinity decreasing in the presence of Fe^{3+}. The incorporation of Fe^{3+} into LDHs enhances absorbance in the UV-Visible region, resulting in a significant decrease in the band-gap value. Additionally, the N_2 adsorption isotherms showed that the specific surface area of the hydrotalcites was greatly increased by exfoliation using the AMOST method. Both, optical and textural properties were dependent on the M^{II}/M^{III} ratio for the compounds and influencing on the photocatalytic activity. De-NO_x tests (Figure 1) showed that increasing the amount of Fe^{3+} in LDHs improved the photocatalytic efficiency for NO gas removal under UV-visible and visible light irradiation, showing high selectivity.

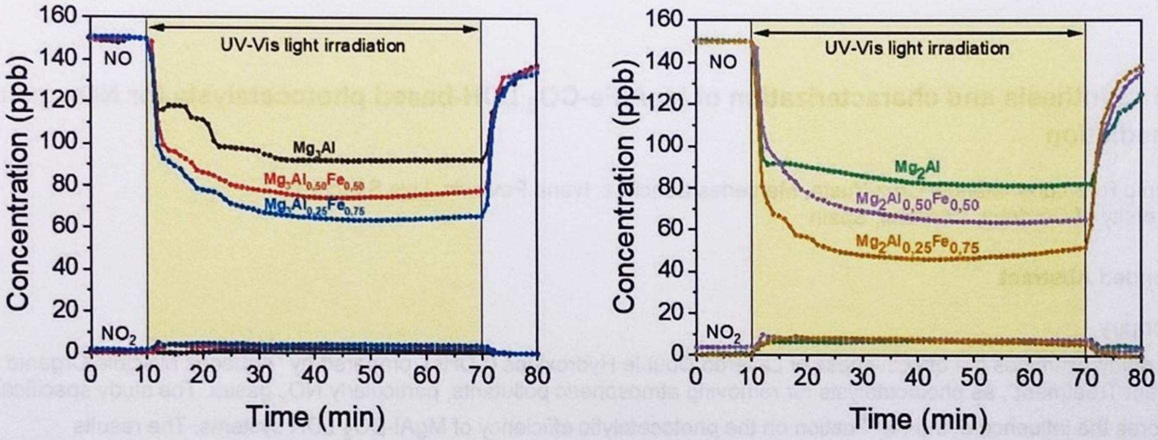

Figure 1. Gas concentration evolution during the photodegradation of NO.

Conclusions

The results indicate the successful synthesis of Fe^{3+}-doped MgAl-CO_3 LDHs. The presence of this metal, enhancing the ability to capture solar radiation, along with the divalent/trivalent metal ratio, plays a crucial role in improving the photocatalytic performance of LDHs for the removal of NO_x gases.

Keywords

LDH; Photocatalyst; Nitrogen oxides; De-NO_x action.

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