

Synthesis and Characterization of Mg²⁺/Al³⁺ Layered Double Hydroxide (LDH) via Stearic Acid Intercalation

Framework

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Structured Abstract

Background: Intercalating anions like Cl⁻ into layered double hydroxides (LDHs) can release pollutants and form poorly structured crystals. This study suggests stearic acid as a sustainable alternative, enhancing crystal quality and reducing environmental impact. LDH-Stearate was synthesized via one-pot stearic acid intercalation and characterized by TGA, XRD, BET, FTIR, and FE-SEM. Results confirmed improved thermal stability, well-organized crystals, and mesoporous characteristics. Stearic acid shows promise for customizing LDH properties for applications in drug delivery, catalysis, and flame retardants, emphasizing the need for further research to optimize intercalation conditions and practical uses.

Methods: LDH-stearate was synthesized using a one-pot procedure by mixing 2.59 g of Mg(NO₃)₂·6H₂O and 1.32 g of Al(NO₃)₃·9H₂O and 1.8 g of stearic acid in a 3:1:1 molar ratio in 100 mL of deionized water. The pH was adjusted to 10 with NaOH (4.0 mol/L), and the mixture was stirred at 80°C for 12 hours. The product was filtered, washed to pH 7, and dried at 80°C for 12 hours. 70% of the dried LDH-stearate was calcined at 250°C for 5 hours, while the remainder was characterized using TGA, XRD, BET, FTIR, and FE-SEM techniques.

Results: Thermogravimetric Analysis (TGA) showed fresh LDH-stearate exhibited significant weight losses at various stages: 5% at 199°C (water elimination), 25% at 317°C (dehydroxylation and CO₃²⁻ breakdown), and further losses at and 422°C (stearate decomposition and metal oxide formation), totalling 60% weight loss. X-ray diffraction (XRD) confirmed successful intercalation with well-defined crystalline structures. BET analysis indicated mesoporous characteristics, while FTIR detected distinctive peaks corresponding to stearic acid. Field Emission Scanning Electron Microscopy (FE-SEM) revealed well-organized, layered structures in both fresh and calcined samples.

Conclusion: In conclusion, Mg-Al LDHs were successfully synthesized and intercalated with stearic acid, forming LDH-Stearate. Stearic acid effectively tailored LDH properties for drug delivery, catalysis, and flame retardants, with future research needed to optimize intercalation conditions and explore practical applications.

Keywords: Layered Double Hydroxide (LDH), Stearic Acid Intercalation, X-ray Diffraction, Mesoporous Structures

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