Junior Science Communications
Faculty of Applied Sciences, UiTM Shah Alam
https://journal.uitm.edu.my/ojs/index.php/JSC

E-ISSN 2637-0689
Vol 66 2026

Colloquium on Applied Sciences 1 2026
19-22 January 2026, Faculty of Applied Sciences, UiTM Shah Alam, Malaysia

Tailoring the Synthesis of Mg/Al-LDH: Optimizing Physicochemical Properties for Maximized Carbon Dioxide Uptake

Nur Rabiatul Fatihah Abd Hafidz[a] & Hamizah Mohd Zaki[ab]*

Structured Abstract

Background: Magnesium-Aluminium layered double hydroxides (MgAl-LDHs) are prime candidates for carbon capture, with the tunable layered architecture, high anion exchange capacity, and unique reversible "memory effect" properties. The CO_2 adsorption performance is governed decisively by synthesis parameters, particularly the Mg/Al molar ratio and thermal treatment. This study directly correlates these synthetic levers with the resulting structural and chemical properties, establishing a framework to engineer MgAl-LDHs with optimized capture capacity.

Methods: MgAl LDH samples with Mg^{2+}/Al^{3+} molar ratios of 2:1 and 3:1 were synthesized via the co-precipitation method at a constant pH of 10 using NaOH, followed by aging and calcination at 450 °C. Repeated intercalation treatments with Na_2CO_3 and subsequent calcination steps were performed to evaluate the structural reconstruction behavior. The synthesized samples were characterized using X-ray diffraction (XRD) to examine phase formation and crystallinity; thermogravimetric analysis (TGA) to assess thermal stability and decomposition behavior; Fourier transform infrared spectroscopy (FTIR) to identify functional groups and interlayer species; and CHNS elemental analysis to determine changes in elemental composition resulting from calcination and intercalation.

Results: XRD analysis confirmed the formation of hydrotalcite-like LDH structures for both MgAl 2:1 and MgAl 3:1 samples, as indicated by characteristic basal reflections at (003) and (006). Intercalation treatments led to measurable variations in peak intensity and basal spacing, suggesting a modified interlayer environment, while calcination resulted in the partial or complete collapse of the layered structure into mixed metal oxides. TGA results revealed distinct stages of weight loss corresponding to dehydration, dehydroxylation, and the decomposition of interlayer anions. FTIR spectra confirmed the presence of hydroxyl groups, interlayer water, carbonate species, and metal-oxide vibrations, aligning with the structural changes induced by treatment. CHNS analysis demonstrated clear variations in carbon and nitrogen content, which corroborate the successful intercalation and subsequent removal of interlayer species.

Conclusion: In conclusion, this study demonstrates that the molar ratio, intercalation cycles, and calcination temperature are critical parameters that dictate the physicochemical properties of MgAl-LDH. The integrated characterization confirmed the controlled synthesis and structural evolution of the material, underscoring its strong potential for tailored adsorption in environmental applications.

Keywords: MgAl layered double hydroxide, XRD, TGA, FTIR, CHNS

*Correspondence: hamiz410@uitm.edu.my

[a] School of Chemistry & Environment, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia

[b] Industrial Waste Conversion Technology Research Group, Universiti Teknologi MARA, Shah Alam, Malaysia