Systematic Investigation of Ternary Layered Double Hydroxide (LDH) for siRNA Binding and Release

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Introduction

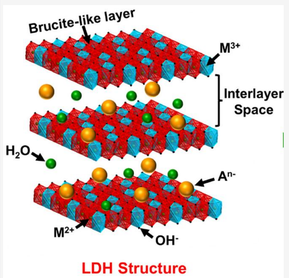


Figure 1. Layered double hydroxide structure

Layered double hydroxide (LDH) is an inorganic material that is promising for small interfering RNA (siRNA) delivery due to its tunable compositions.

LDHs are **positively charged**, suitable to interact with the **negatively charged siRNA** via electrostatic interactions.

Previous studies have investigated binary LDH. However, the influence of ternary LDH on siRNA binding remains insufficiently explored.

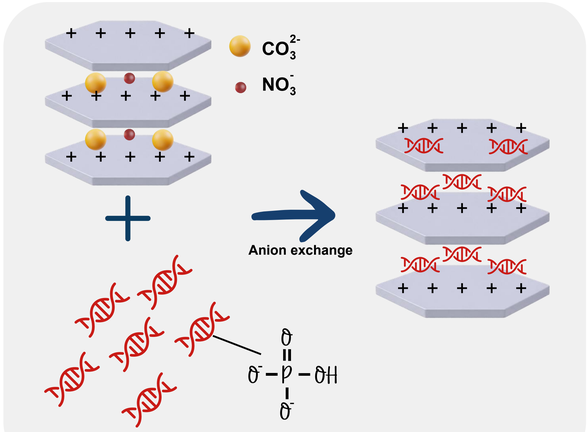


Figure 2. LDH and RNA binding mechanism

Objective

To design the **ternary LDH (NiAlFe LDH, ZnAlFe LDH, and MgAlFe LDH)** and evaluate their structural, physicochemical properties and siRNA-LDH binding performance.

Methodology

The ternary LDH samples were prepared by a facile co-precipitation method.

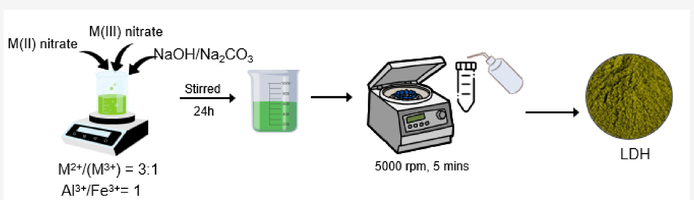


Figure 3. Synthesis of ternary LDH

→ Characterizations:
- FT-IR
- N_2 ads-des isotherm
- SEM-EDS

→ siRNA binding assay



Physicochemical properties

N_2 adsorption-desorption analysis exhibits mesopore characteristics, and SEM images confirm the layered structure of each LDH with different aggregation. FT-IR spectrum shows vibrational bands associated with hydroxyl groups, interlayer species, & M-O bonds

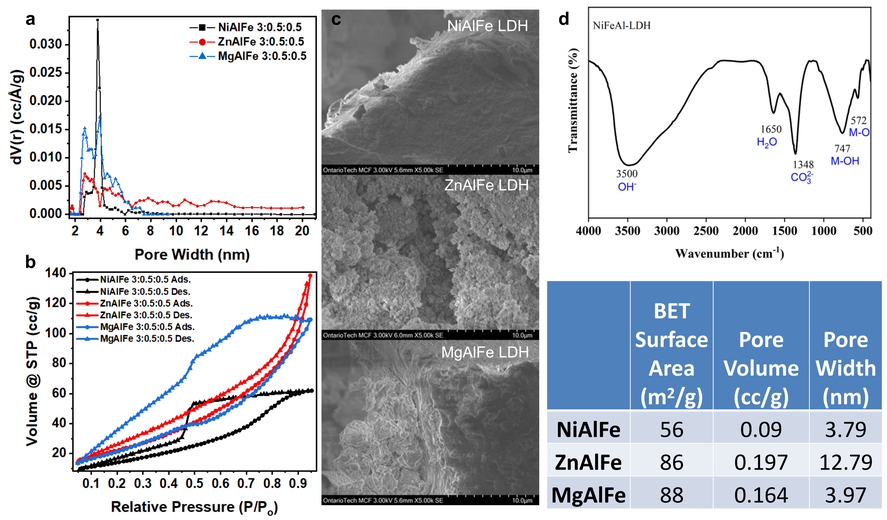


Figure 4. (a) Pore width distributions, (b) N_2 adsorption-desorption isotherms, (c) SEM images of all obtained samples, and (d) FT-IR spectra of NiAlFe LDH

	BET Surface Area (m^2/g)	Pore Volume (cc/g)	Pore Width (nm)
NiAlFe	56	0.09	3.79
ZnAlFe	86	0.197	12.79
MgAlFe	88	0.164	3.97

siRNA and LDH binding performance

The EC_{50} represents the LDH concentration required to achieve 50 percent of the defined binding response. Dose-response curve fitting uses a sigmoidal function in OriginPro to estimate the EC_{50}.

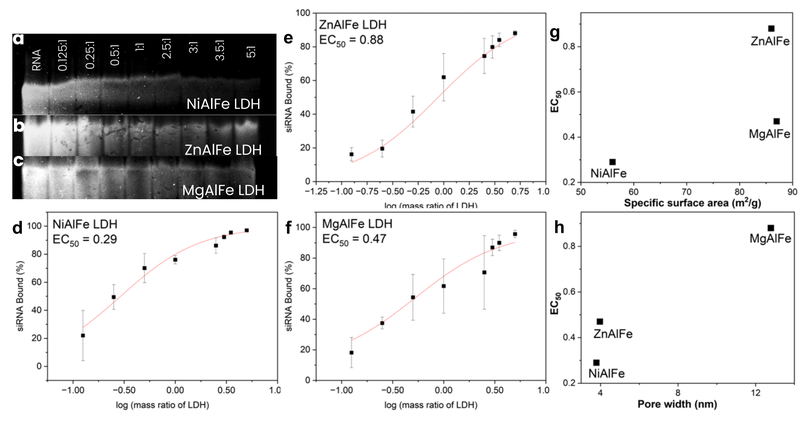


Figure 5. Gel electrophoresis of LDH:siRNA at different mass ratios of (a) NiFeAl LDH, (b) ZnAlFe LDH, (c) MgAlFe LDH, Dose-response curve of EC_{50} of (d) NiFeAl LDH, (e) ZnAlFe LDH, (f) MgAlFe LDH, (g) Specific surface area vs EC_{50}, and (h) Pore width vs EC_{50}.

NiAlFe LDH shows the lowest EC_{50} values, 0.29, indicating that the lowest concentration is required to achieve the midpoint

Conclusion & future work

- ❑ Three ternary LDHs exhibit different physicochemical properties and siRNA-binding performance, with NiAlFe LDH showing the lowest EC_{50} among the investigated samples.
- ❑ Further investigation will evaluate the siRNA release behavior to assess the potential of ternary LDH as siRNA delivery carriers.

Acknowledgements

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References

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