Supplementary Information

Functionalized Mg/Fe layered double hydroxides for high adsorption capacity of rare earth from waste water

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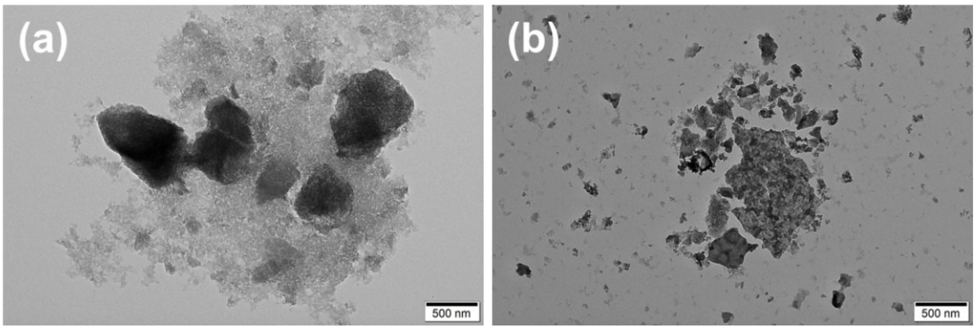

Figure S.1 (a) TEM images of TC-MgFe LDH; (b) TEM images of TC-MgFe LDH@La^{3+}.

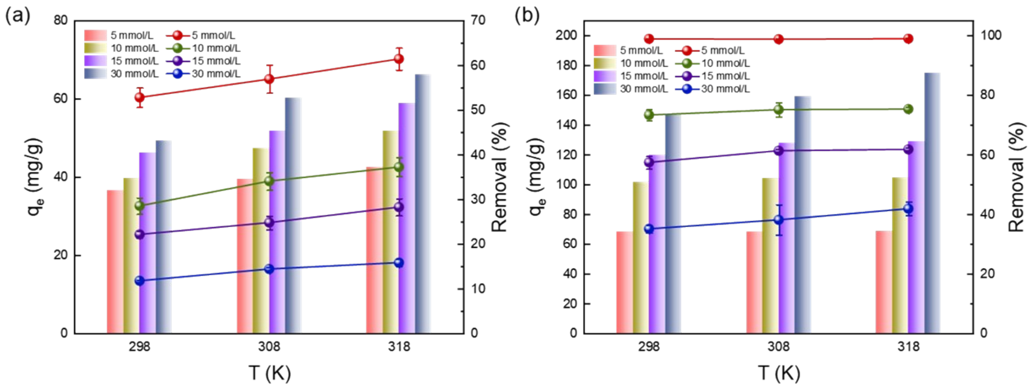

Figure S.2 Effect of different temperatures on the adsorption of La^{3+} by (a) MgFe LDH and (b) TC-MgFe LDH.

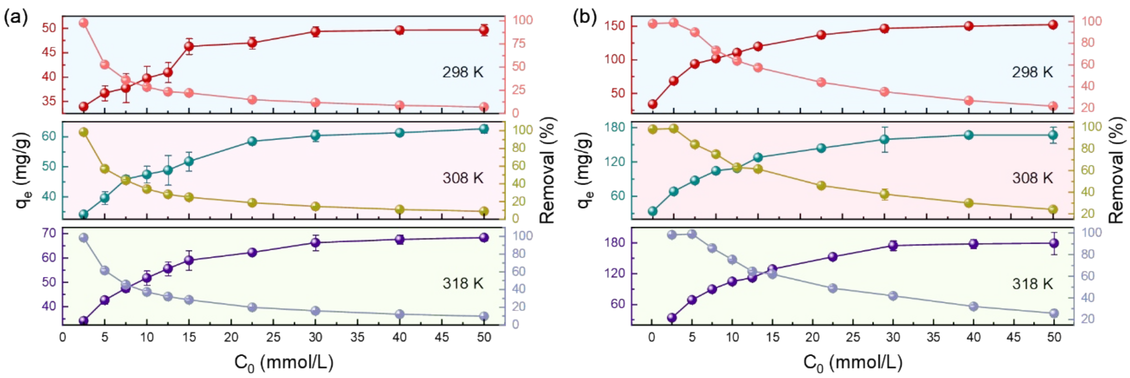

Figure S.3 Effect of initial concentration on the adsorption of La^{3+} by **(a)** MgFe LDH and **(b)** TC-MgFe LDH at different temperatures.

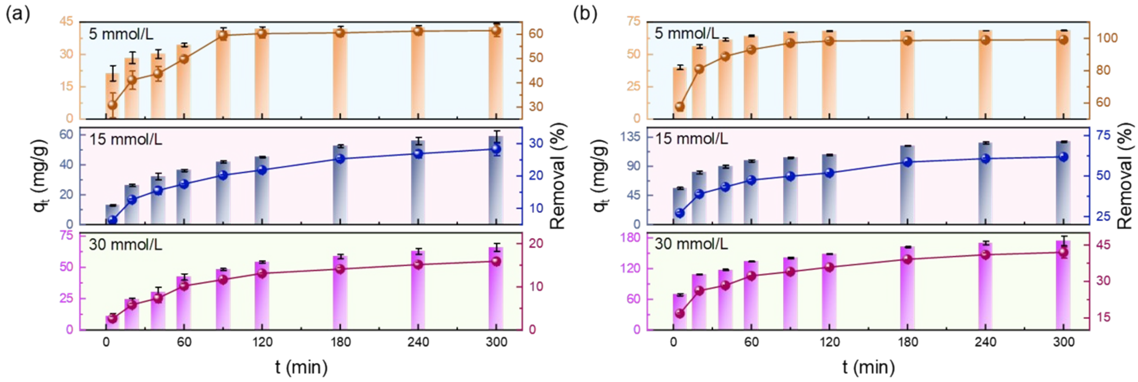

Figure S.4 Effect of contact time on the adsorption of La^{3+} by **(a)** MgFe LDH and **(b)** TC-MgFe LDH at different initial concentrations.

Adsorption isotherm Equations:

The Langmuir adsorption isotherm model is expressed by formula (S.1):

$$q_e = \frac{q_m K_L C_e}{1 + K_L C_e} \tag{S.1}$$

C_e (mg/L) and q_e (mg/g) are the equilibrium concentration in the liquid phase and the equilibrium adsorption capacity during the adsorption process, respectively. q_m (mg/g) represents the maximum adsorption capacity, and the adsorption rate constant K_L (L/mg) characterizes the affinity between LDH and La^{3+}.

The Freundlich adsorption isotherm model is expressed by formula (S.2):

$$q_e = K_F C_e^{1/n} \tag{S.2}$$

K_F is the Freundlich constant related to adsorption capacity and represents a measure of the surface area of the adsorbent. The heterogeneity of the LDH surface and the degree of adsorption can be quantified by the size of $1/n$. The $1/n$ value for favorable adsorption ranges from 0-1, with larger values indicating greater attraction between LDH and La^{3+} and a more uneven distribution of the adsorbent.

The Temkin adsorption isotherm model is expressed by formula (S.3):

$$q_e = A_T + B_T \ln C_e \tag{S.3}$$

The D-R adsorption isotherm model is expressed by formula (S.4):

$$q_e = q_m exp\left(- k_D \varepsilon^2 \right) \tag{S.4}$$

$$\varepsilon = RT \ln(1 + \frac{1}{C_e}) \tag{S.5}$$

$$E = (2 \times k_D)^{\frac{-1}{2}} \tag{S.6}$$

In the above formula, k_D is a parameter related to the adsorption free energy E, and the symbol ε is the Polanyi potential, and its correlation can be expressed by formula (S.5). When the adsorbent is transferred from the solution to the solid surface, the average E of each adsorbent molecule can be evaluated by the D-R parameter k_D, which can be calculated using formula (S.6).

Adsorption kinetic Equations:

The two kinetic models can be expressed by formulas (S.7) and (S.8) respectively.

$$q_t = q_e\left(1 - e^{-k_1 t}\right) \quad \text{(S.7)}$$

$$q_t = \frac{k_2 q_e^2 t}{1 + k_2 q_e t} \quad \text{(S.8)}$$

In the above formula, q_e (mg/g) is the equilibrium adsorption capacity, and q_t (mg/g) is the adsorption capacity at time t. The constants k_1 (min^{-1}) and k_2 (g/mg·min) are the rate constants of the PFO and PSO kinetic models, respectively.

Table S.1 The maximum adsorption amount of La^{3+} on MgFe LDH and TC-MgFe LDH at different temperatures.

Adsorbent	Temperature (K)	q_m (mg/g)
MgFe LDH	298	49.65
	308	62.68
	318	68.38
TC-MgFe LDH	298	152.32
	308	166.97
	318	179.38