Supporting Information

La^{3+}:Ni-Cl oxyhydroxide gels with enhanced electroactivity as positive materials for hybrid supercapacitors

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Calculation equation of energy density and power density of hybrid supercapacitors:

The specific energy density (E, Wh kg^{-1}) and power density (P, W kg^{-1}) for an asymmetric supercapacitor can be calculated using the following equations:

$$E = \frac{\int I \cdot V(t)dt}{3.6m}$$

$$P = \frac{3600E}{\Delta t}$$

where E (Wh kg^{-1}) is the energy density, P (W kg^{-1}) is the power density, I (A) is the discharge current, $\int I \cdot V(t)dt$ is the area under the discharge curve, m (g) is the total mass of the active material (positive and negative electrodes), and Δt (s) is the discharge time.

Fig. S1 Photo of La^{3+}:Ni-Cl oxyhydroxide gels.

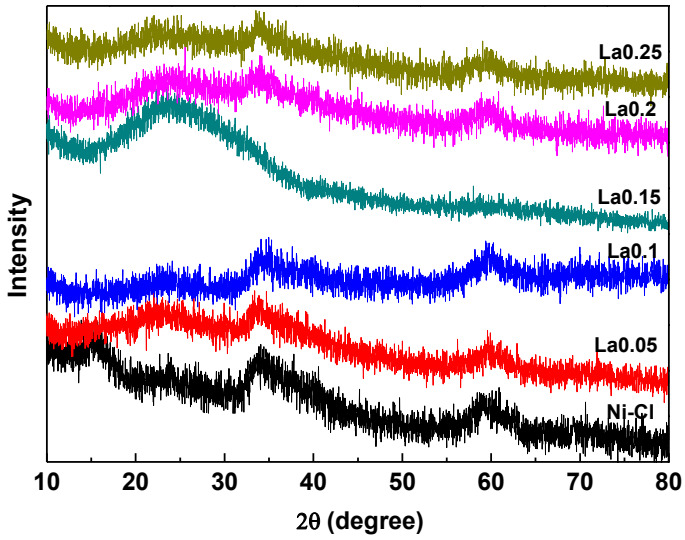

Fig. S2 XRD patterns of Ni-Cl oxyhydroxide and La^{3+}:Ni-Cl oxyhydroxide gels with adding different amount of La^{3+}.

Table S1 Elemental ratios calculated based on EDS analysis of Ni-Cl oxyhydroxide gels with different La^{3+} amounts before and after electrochemical test.

Sample	As-obtained sample			After electrochemical test		
	La/Ni	La/(Ni+La)	Cl/(Ni+La)	La/Ni	La/(Ni+La)	Cl/(Ni+La)
Ni	/	/	0.35	/	/	0.022
La0.05	0.020	0.022	0.29	0.031	0.030	0.019
La0.10	0.050	0.048	0.30	0.044	0.042	0.019
La0.15	0.072	0.067	0.23	0.074	0.069	0.023
La0.20	0.136	0.120	0.26	0.081	0.075	0.038
La0.25	0.125	0.111	0.25	0.113	0.102	0.043

Table S2 Element ratios of Ni-Cl oxyhydroxide gels with different La^{3+} amounts from EDS before electrochemical test.

Sample	Ni	O	Cl	C	La	La/Ni	La/(Ni+La)	Cl/(Ni+La)
Ni	18.58	48.81	6.56	26.05	-	-	-	0.35
La0.05	4.16	43.12	1.25	51.48	0.092	0.02	0.022	0.29
La0.1	26.16	45.9	8.36	18.26	1.31	0.050	0.048	0.30
La0.15	27.62	42.73	6.84	20.83	1.98	0.072	0.067	0.23
La0.2	14.67	43.51	4.26	35.57	2	0.136	0.120	0.26
La0.25	14.53	59.05	4.12	20.48	1.82	0.125	0.111	0.25

Table S3 Element ratios of Ni-Cl oxyhydroxide gels with different La^{3+} amounts from EDS after electrochemical test.

Sample	Ni	La	Cl	K	O	La/Ni	La/(Ni+La)	Cl/(Ni+La)
Ni	16.08	0	0.35	13.05	39.44	-	-	0.022
La0.05	19.77	0.61	0.39	8.12	48.32	0.031	0.030	0.019
La0.1	19.24	0.84	0.39	9.77	42.44	0.044	0.042	0.019
La0.15	15.85	1.17	0.39	5.78	39.92	0.074	0.069	0.023
La0.2	15.76	1.28	0.64	14.07	47.22	0.081	0.075	0.038
La0.25	11.59	1.31	0.56	7.81	54.40	0.113	0.102	0.043

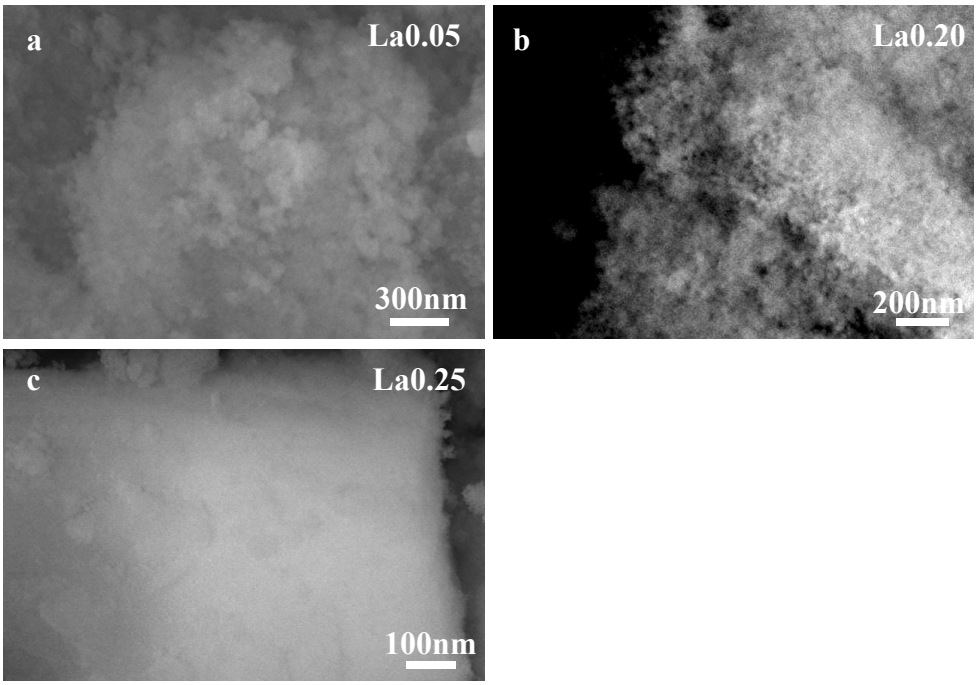

Fig. S3 SEM images of Ni-Cl oxyhydroxide and La^{3+}:Ni-Cl oxyhydroxide gels with adding different amount of La^{3+}: (a) 0.05 mmol, (b) 0.20 mmol, (a) 0.25mmol,

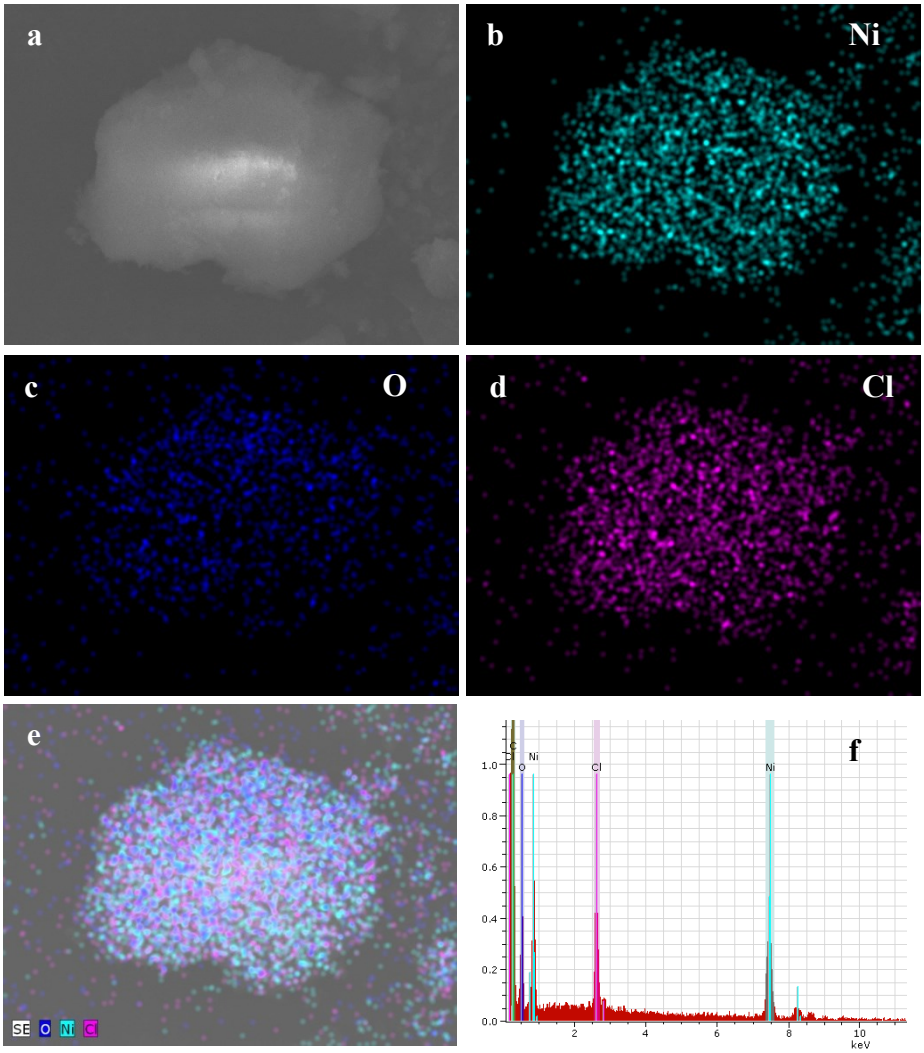

Fig. S4 SEM image (a), element mapping (b-e) and EDS (f) of Ni-Cl oxyhydroxide gels.

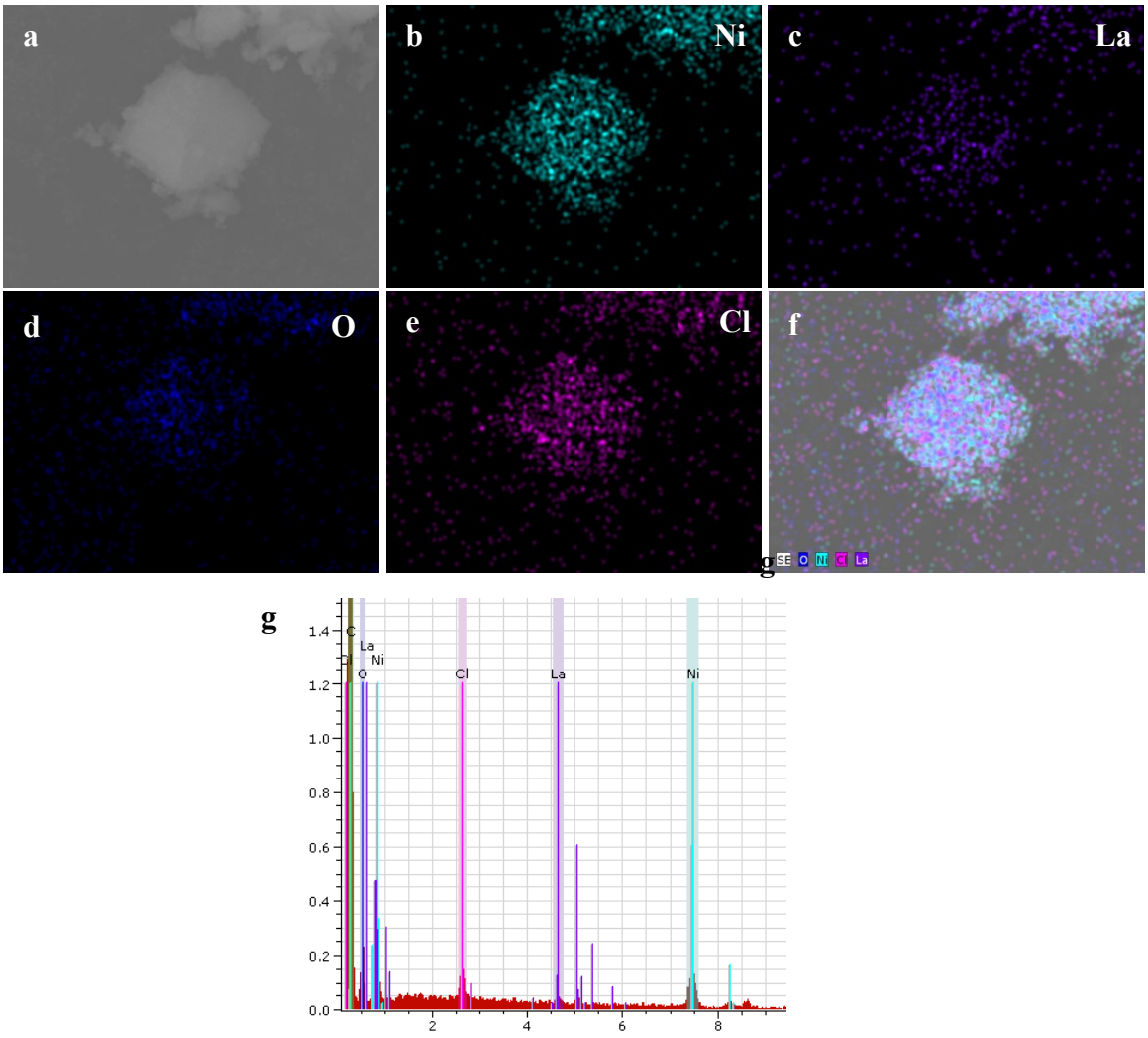

Fig. S5 SEM image (a), element mapping (b-f) and EDS (g) of La^{3+}:Ni-Cl oxyhydroxides (La0.15).

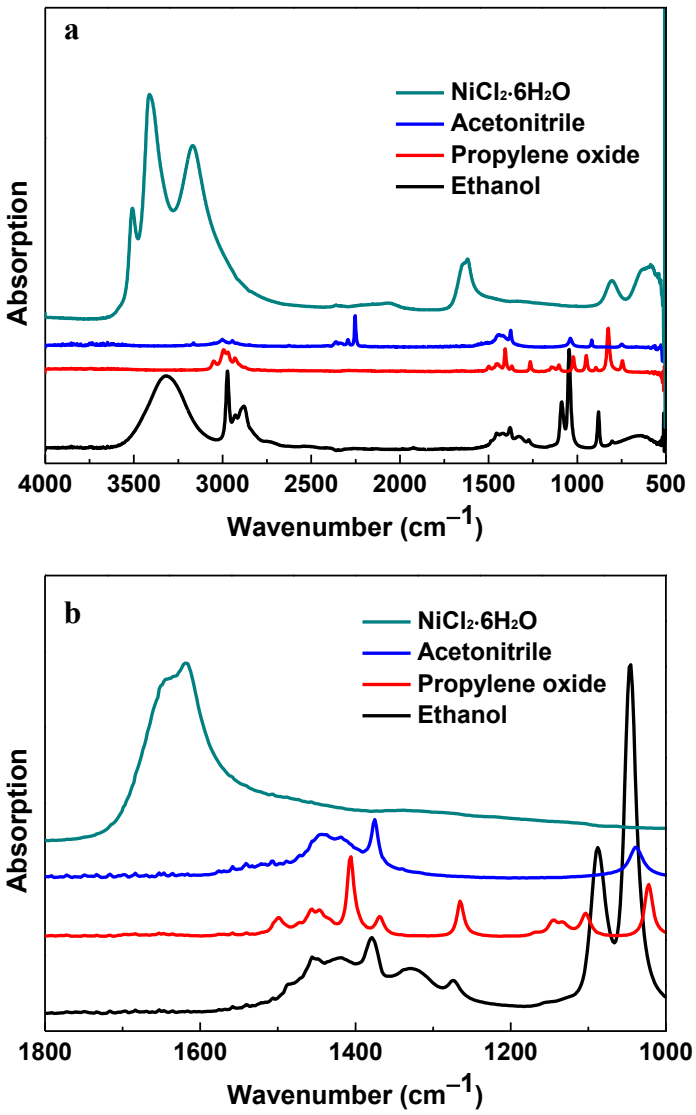

Fig. S6. (a and b) FTIR spectra of ethonal, propylene oxide, acetonitrile, and $NiCl_2 \cdot 6H_2O$.

Table S4 Compare of energy densities and power densities of hybrid supercapacitors reported in literatures

Supercapacitors	Potential window	Power density	Energy density	Ref.
3D-ICHA a-$Ni(OH)_2$//AC	1.55V	0.14 kW/kg 2.9 kW/kg	14.8 Wh/kg 9.0 Wh/kg	1
Ni foam-supported Ni_2P nanosheet//AC	1.4V	0.34 kW/kg 5.3 kW/kg	26.0 Wh/kg 10.0 Wh/kg	2
$Ni(OH)_2$/graphene // porous graphene	1.6V	0.17 kW/kg	77.8 Wh/kg	3
$Ni(OH)_2$-$Co_2(OH)_3Cl$ bilayer nanocomposites//AC	1.7 V	0.26 kW/kg 4.2 kW/kg	37.6 Wh/kg 20.0 Wh/kg	4
CNT/$Ni(OH)_2$//RGO	1.8 V	1.8 kW/kg 2.7 kW/kg	35.0 Wh/kg 26.2 Wh/kg	5
Co_3O_4@$Ni(OH)_2$//AC	1.65V	0.033W/kg 1.7 kW/kg	41.8 Wh/kg 18.4 Wh/kg	6
Co_3O_4@$Ni(OH)_2$//RGO	1.65V	0.036 kW/kg 1.9 kW/kg	41.9 Wh/kg 18.5 Wh/kg	6
La^{3+}:Ni-Cl oxyhydroxide gel (La0.05)//AC	1.5V	1.0 kW/kg 13.9 kW/kg	30.7 Wh/kg 13.9 Wh/kg	This work

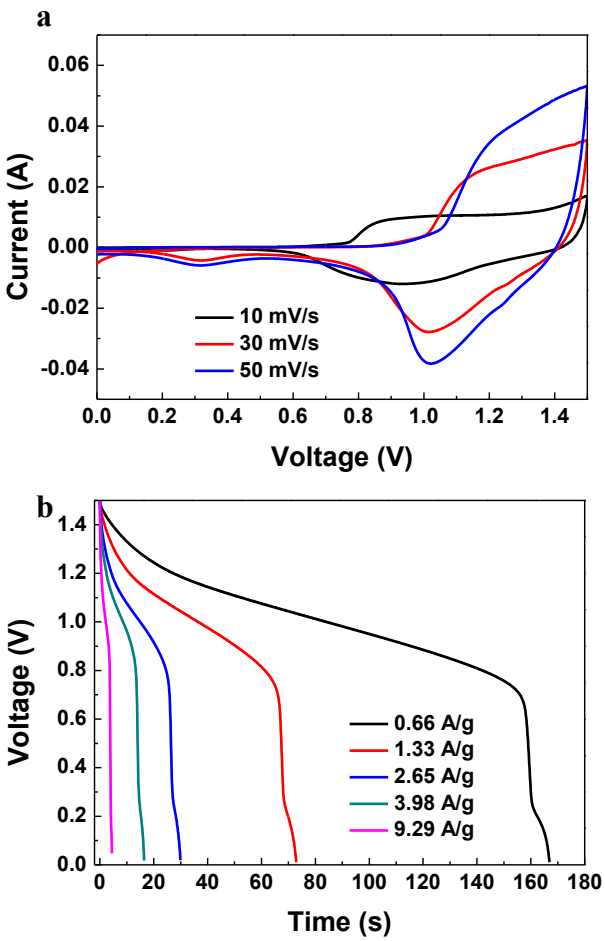

Fig. S7 (a) CV curves at different scan rates and (b) discharge curves of Ni-Cl oxyhydroxide//AC.

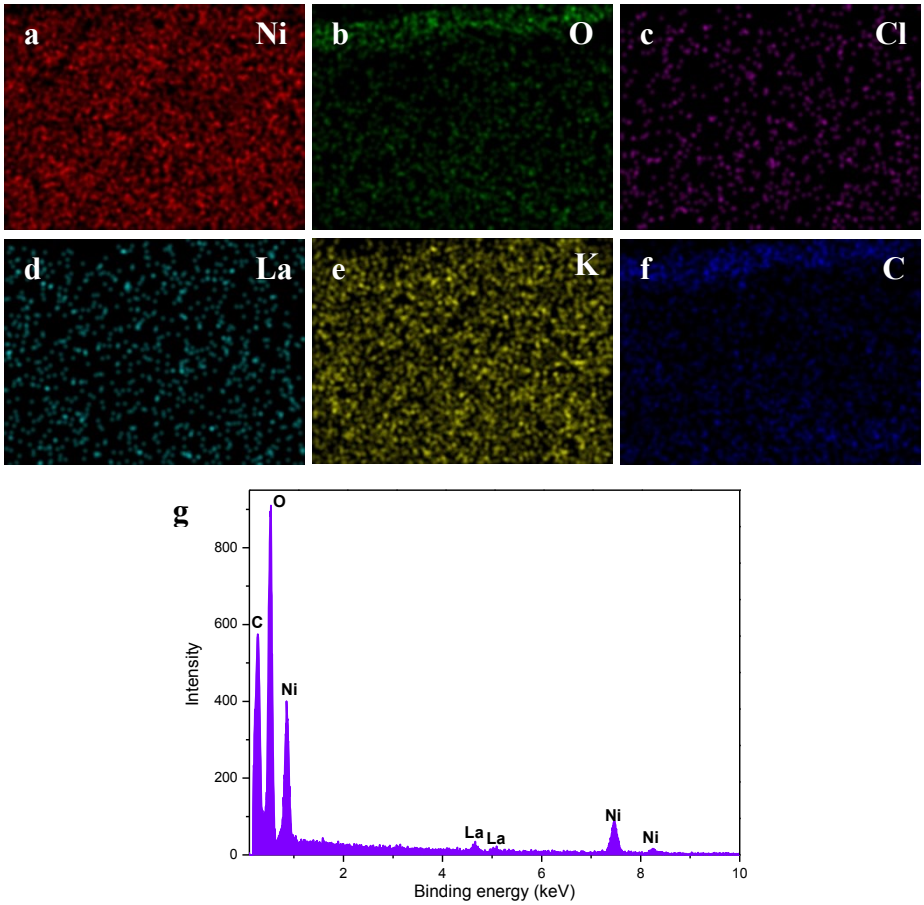

Fig. S8 Elemental mapping of La^{3+}:Ni-Cl oxyhydroxide gel (La0.10) electrode after electrochemical testing.

References:

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