

Supplementary Material for- Enhancing ZnS supercapacitance through Ni doping using a facile chemical co-precipitation method

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1. The Crystalline properties of pure and Ni-doped ZnS

Table S1. Structural parameters such as d-spacing and crystallite size comparison of pure and Ni-doped ZnS samples obtained from XRD curves.

Sample	2θ (degree)	d-spacing (Å)	Lattice constant (Å)	Crystallite size (nm)	Micro strain (ε)	Dislocation density (δ) (x 10 ⁻² nm ⁻²)	Stacking fault (SF)
ZnS	28.90	3.0869	5.347	1.887	0.0182	0.281	0.0374
Ni 1%-ZnS	28.96	3.0807	5.336	1.891	0.0182	0.280	0.0373
Ni 3%-ZnS	28.95	3.0817	5.338	1.823	0.0188	0.301	0.0387
Ni 5%-ZnS	28.86	3.0911	5.354	1.839	0.0186	0.295	0.0384

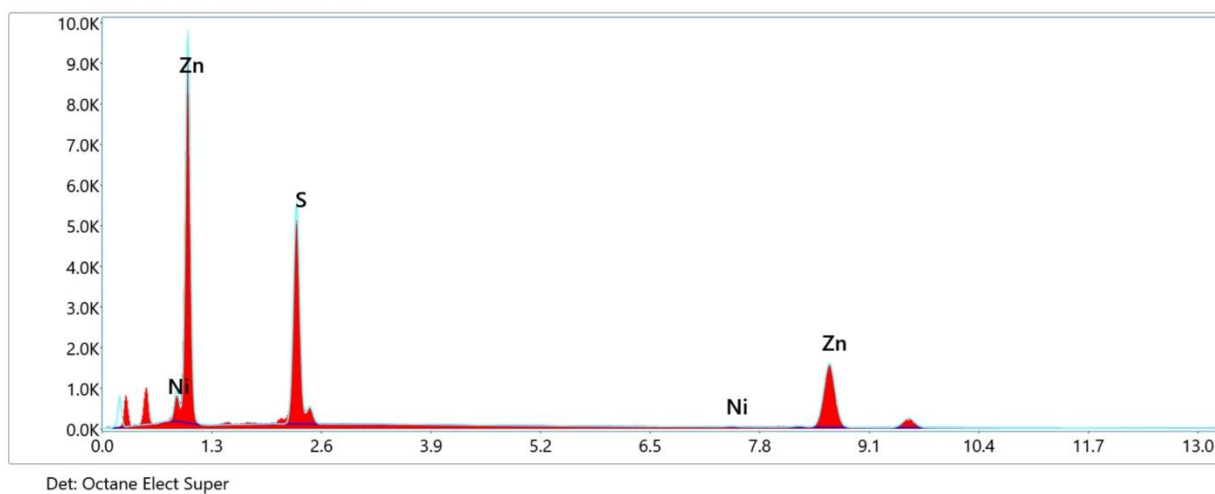


Figure S1. EDX spectra of Ni 3%- ZnS

2. BET surface area and porosity analysis of pure and Ni-doped ZnS

Table S2. BET result comparison of pure and Ni-doped ZnS samples.

Sample	BET surface area ($\text{m}^2 \text{g}^{-1}$)	Average pore diameter (nm)	Total pore volume at $p/p_0=0.99$ ($\text{cm}^3 \text{g}^{-1}$)
ZnS	30.89	5.61	0.043
Ni 1%: ZnS	88.69	3.52	0.078
Ni 3%: ZnS	82.44	2.94	0.061
Ni 5%: ZnS	78.27	4.20	0.082

3. Specific capacitance comparison of pure and Ni-doped ZnS – CV & GCD

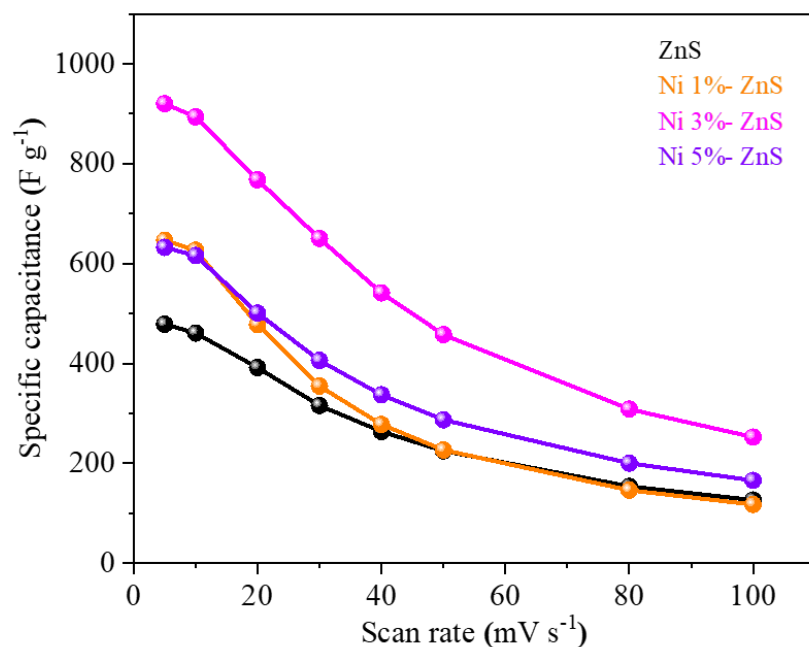


Figure S2. Specific capacitance vs scan rate (from CV) plot for pure and Ni-doped ZnS samples.

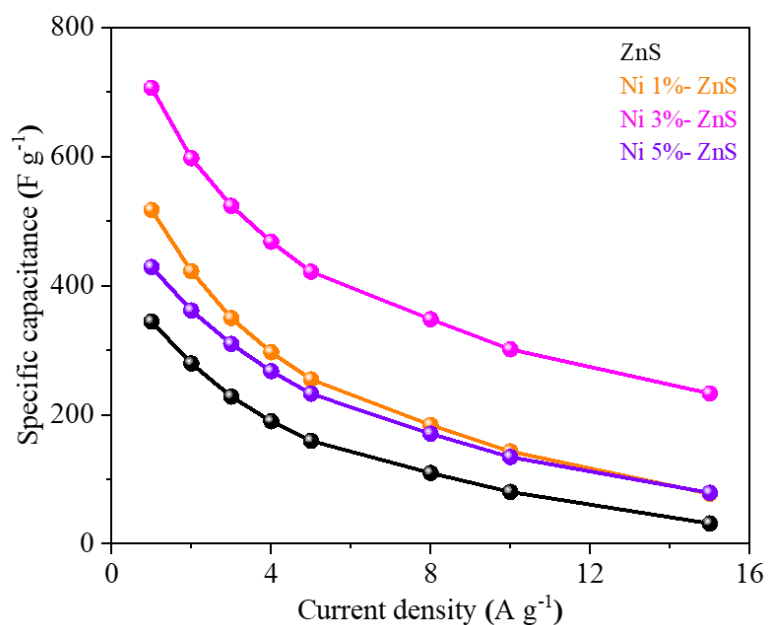


Figure S3. Specific capacitance vs current density (from GCD) plot for pure and Ni-doped ZnS samples.

4. EIS comparison of pure and Ni-doped ZnS

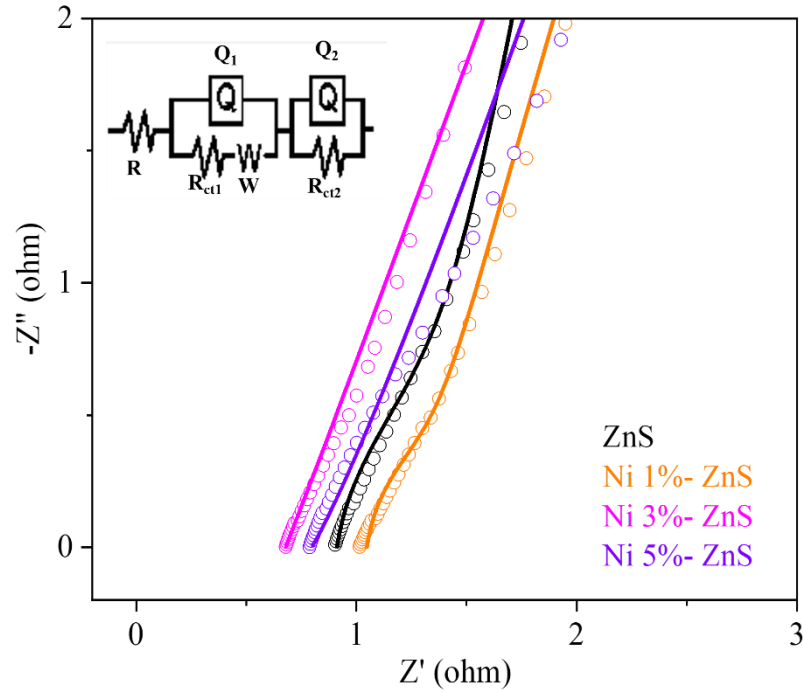


Figure S4. Zoomed region of Nyquist plot comparing pure and Ni-doped ZnS. The inset shows the corresponding equivalent circuit for the fitted curve. All the EIS curves are taken at their corresponding Open Circuit Voltage (OCV) value.

Table S3. Comparing the R_s , R_{ct} values of pure and Ni-doped ZnS samples.

Sample	R_s (ohm)	R_{ct1} (ohm)	R_{ct2} (ohm)	$R_{ct1} + R_{ct2}$ (ohm)
ZnS	0.912	0.461	234.2	234.661
Ni 1%: ZnS	1.047	0.224	81.3	81.524
Ni 3%: ZnS	0.679	0.220	20.1	20.320
Ni 5%: ZnS	0.796	0.306	193.0	193.306

5. Electrochemical stability comparison of pure and Ni-doped ZnS

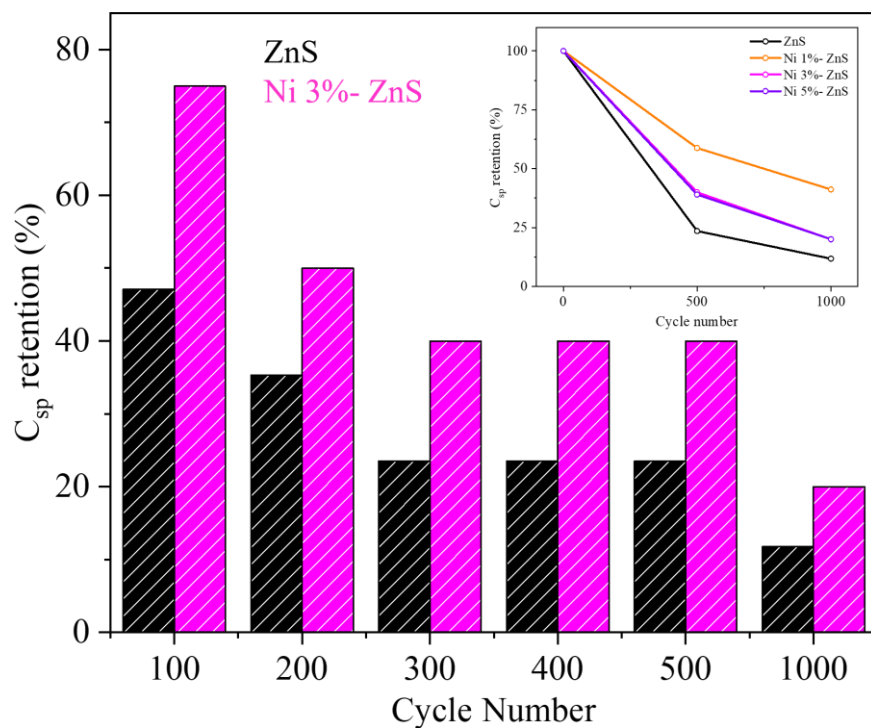


Figure S5. Specific capacitance (C_{sp}) retention of pure and Ni 3%-ZnS during electrochemical stability test at GCD current density of 2 A g^{-1} . The inset shows retention of pure and Ni-doped ZnS after 500 and 1000 GCD cycles.

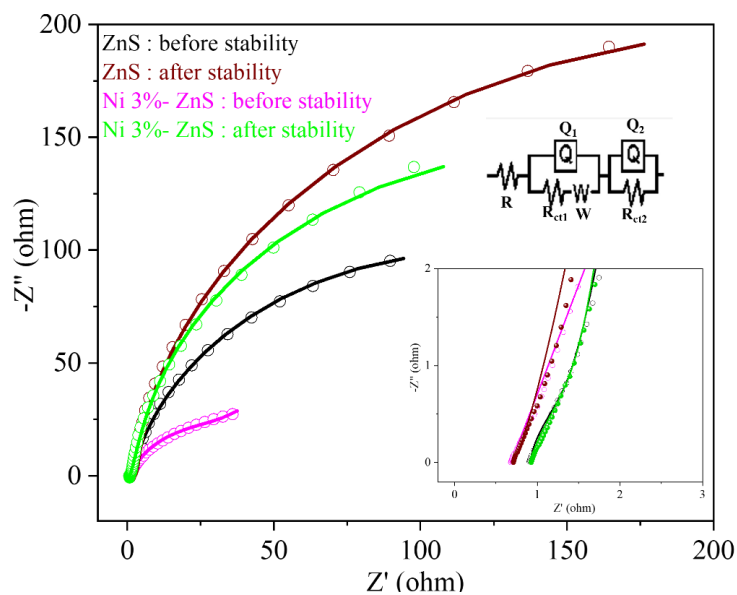


Figure S6. Nyquist plot comparison of pure and Ni 3%-ZnS before and after 1000 GCD cycles.

Table S4. Comparing the R_s , R_{ct} values of pure and Ni 3%- ZnS before and after 1000 GCD cycles.

Sample	Before stability			After stability		
	R_s (ohm)	R_{ct1} (ohm)	R_{ct2} (ohm)	R_s (ohm)	R_{ct1} (ohm)	R_{ct2} (ohm)
ZnS	0.912	0.461	234.2	0.917	0.646	439.4
Ni 3%: ZnS	0.679	0.220	20.1	0.708	0.374	231.8

6. Electrochemical performance comparison table

Table S5. Specific capacitance comparison with previously reported ZnS/doped ZnS materials.

Material	Specific Capacitance ($\text{F g}^{-1} / \text{C g}^{-1}$)	Scan rate (mV s^{-1}) / Current density (A g^{-1})	Reference
Ni-ZnS thin films	223 F g^{-1}	10 mV s^{-1}	1
Mn- ZnS nanosheet@NF	1905 F g^{-1}	1 A g^{-1}	2
Mn-ZnS nanoflakes@NF	1558 F g^{-1}	1 A g^{-1}	2
Mn-ZnS nanoneedles@NF	1517 F g^{-1}	1 A g^{-1}	2
ZnS nanoflakes @NF	659 C g^{-1}	2 A g^{-1}	3
MgCo_2O_4 @ZnS	910 F g^{-1}	1 A g^{-1}	4
Mo-ZnS@NF	2208 F g^{-1}	1 A g^{-1}	5
2D ZnS/FeS @CC	1367.5 F g^{-1}	3 A g^{-1}	6
graphitic- C_3N_4 /ZnS	497.7 F g^{-1}	1 A g^{-1}	7
NiS@ZnS@NF	1533 F g^{-1}	7.5 A g^{-1}	8
ZnS NPs	824 F g^{-1}	1 A g^{-1}	9
Zn-Co-S	1646 F g^{-1}	1 A g^{-1}	10
ZnS/G-60	197.1 F g^{-1}	5 mV s^{-1}	11
ZnS@CNT	347.3 F g^{-1}	0.5 A g^{-1}	12
T-NT/ZnS flower like	226 F g^{-1}	20 mV s^{-1}	13
ZnS-CT	747 F g^{-1}	5 mV s^{-1}	14
$\text{Zn}_{0.76}\text{Co}_{0.24}\text{S}$ /CFP	300 F g^{-1}	1 A g^{-1}	15
ZnS nanowires @NF	781 F g^{-1}	0.5 A g^{-1}	16
$\text{Cu}_5\text{Sn}_2\text{S}_7$ /ZnS	200 F g^{-1}	1 A g^{-1}	17
ZnO@ZnS	603.8 F g^{-1}	2 A g^{-1}	18
Ni-ZnS microsphere	261.5 F g^{-1}	5 mV s^{-1}	19
ZnS microsphere	216.2 F g^{-1}	5 mV s^{-1}	19
Cu-ZnS nanoflake	743 F g^{-1}	1 A g^{-1}	20
Fe-ZnS microsphere	604.5 F g^{-1}	1 A g^{-1}	21
ZnS	460.7 F g^{-1}	10 mV s^{-1}	This work
Ni 3%- ZnS	893.5 F g^{-1}	10 mV s^{-1}	This work
Ni 3%- ZnS	920.1 F g^{-1}	5 mV s^{-1}	This work

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