

Supplementary information

**Morphology-Dependent Synergy in High-performance MnO₂/Activated Carbon
Electrodes via Facile Dry-Mixing**

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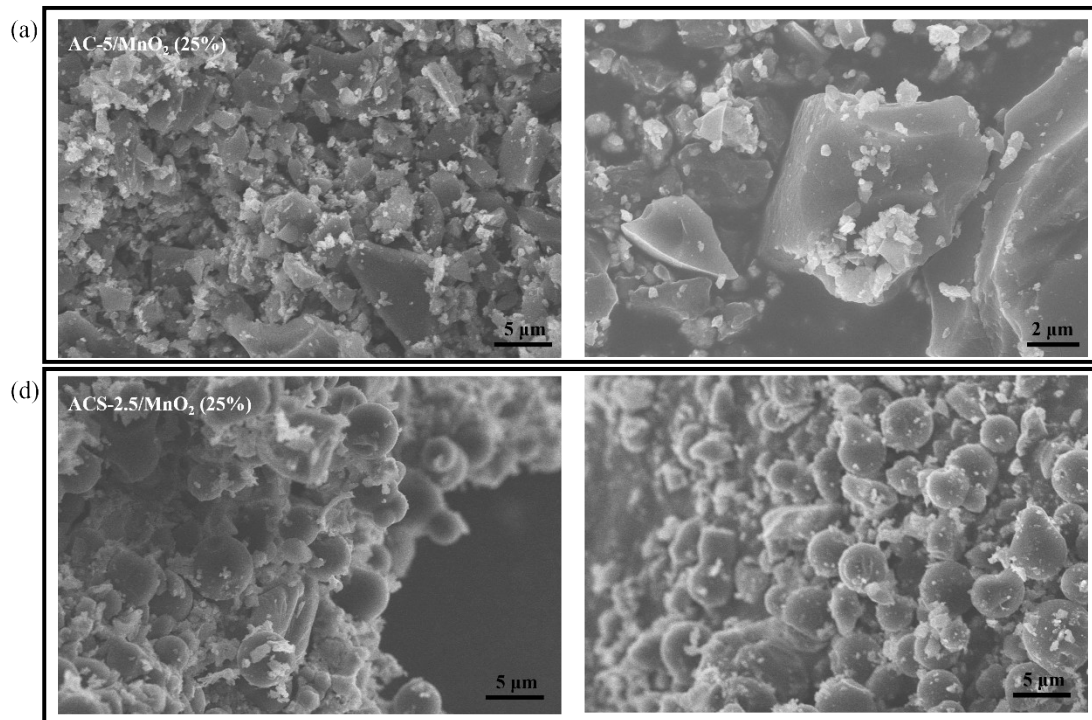


Figure S1. SEM images of: (a) AC-5/MnO₂ (25%) and (b) ACS-2.5/MnO₂ (25%).

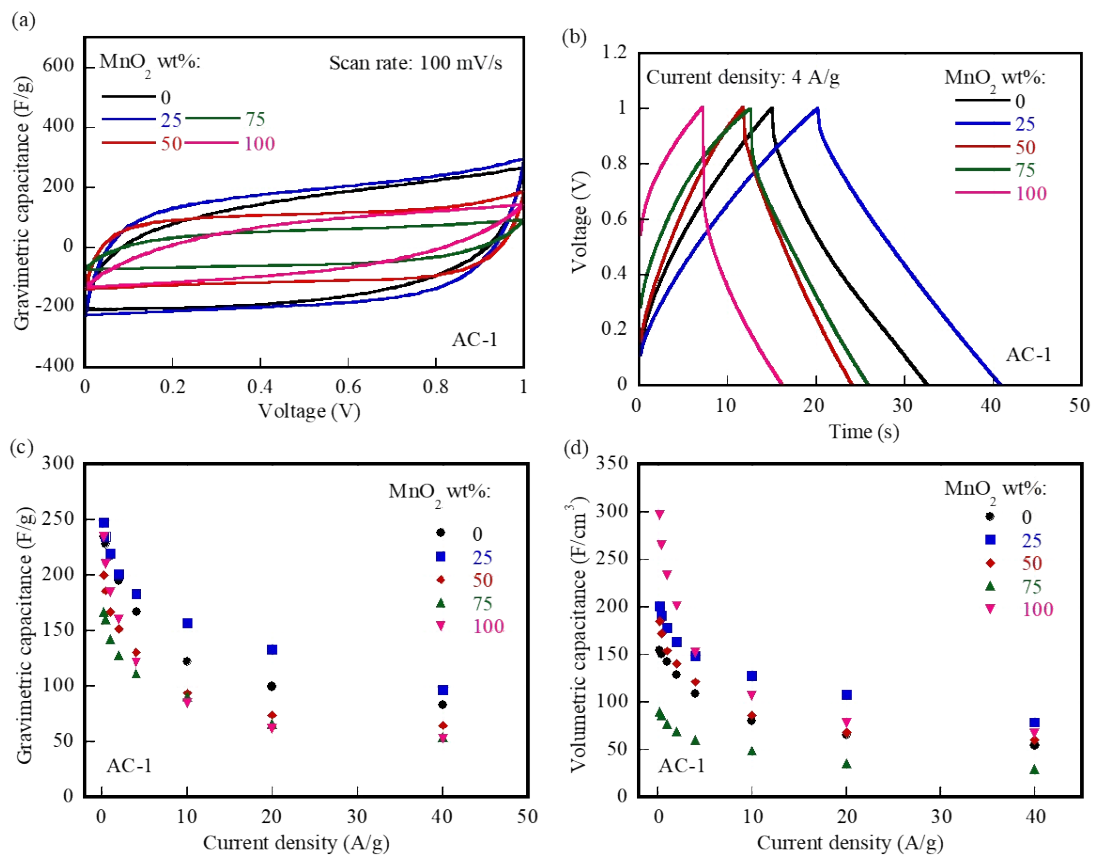


Figure S2. Electrochemical performances of SCs based on the composite of AC-1 and MnO_2 in different mass ratios: (a) CV curves at 100 mV/s, (b) GCD curves at 4 A/g, (c) variation of gravimetric capacitance with current density, and (d) variation of volumetric capacitance with current density.

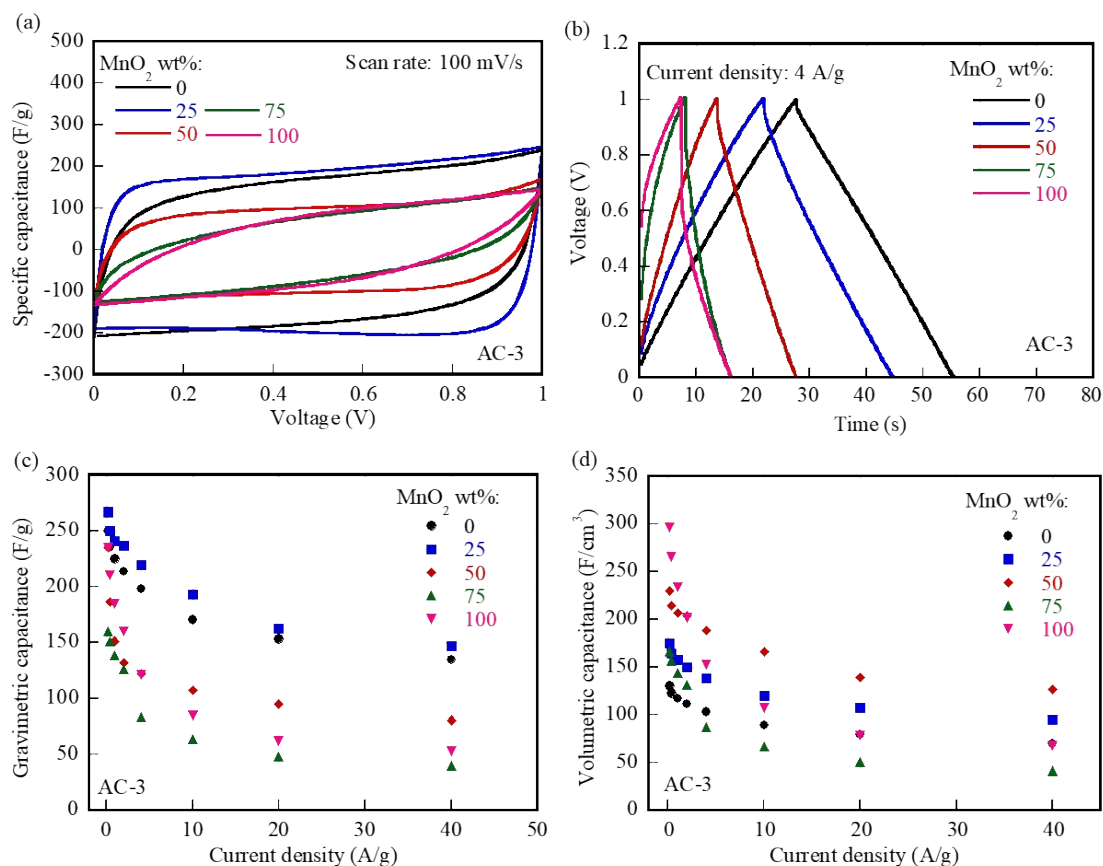


Figure S3. Electrochemical performances of SCs based on the composite of AC-3 and MnO_2 in different mass ratios: (a) CV curves at 100 mV/s, (b) GCD curves at 4 A/g, (c) variation of gravimetric capacitance with current density, and (d) variation of volumetric capacitance with current density.

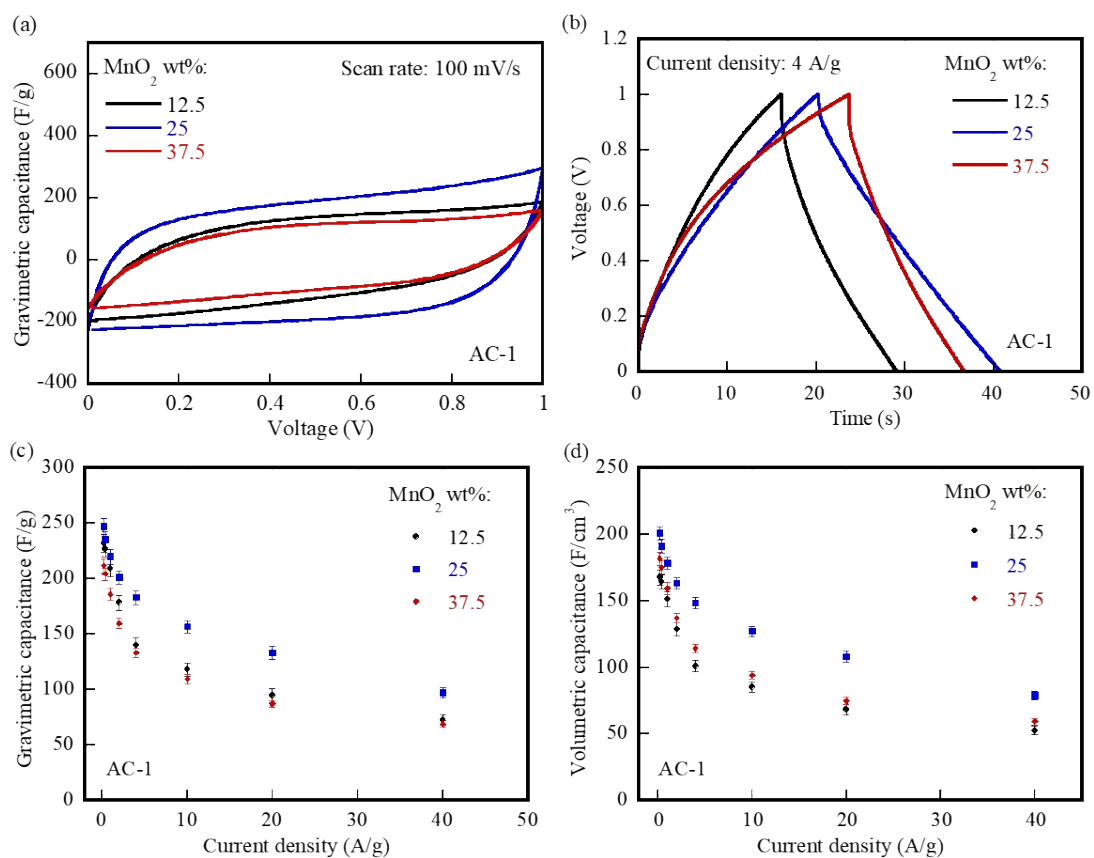


Figure S4. Electrochemical performances of SCs based on the composite of AC-1 and MnO_2 in different mass ratios: (a) CV curves at 100 mV/s, (b) GCD curves at 4 A/g, (c) variation of gravimetric capacitance with current density, and (d) variation of volumetric capacitance with current density.

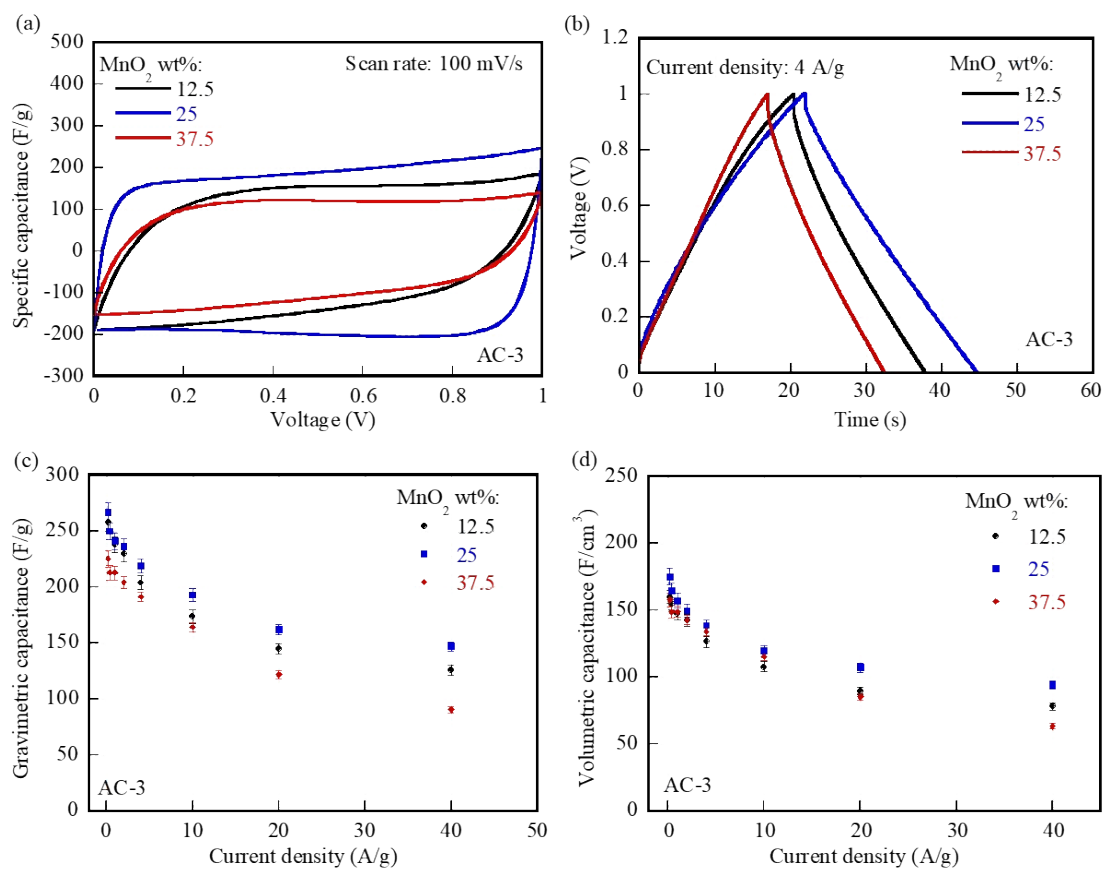


Figure S5. Electrochemical performances of SCs based on the composite of AC-3 and MnO₂ in different mass ratios: (a) CV curves at 100 mV/s, (b) GCD curves at 4 A/g, (c) variation of gravimetric capacitance with current density, and (d) variation of volumetric capacitance with current density.

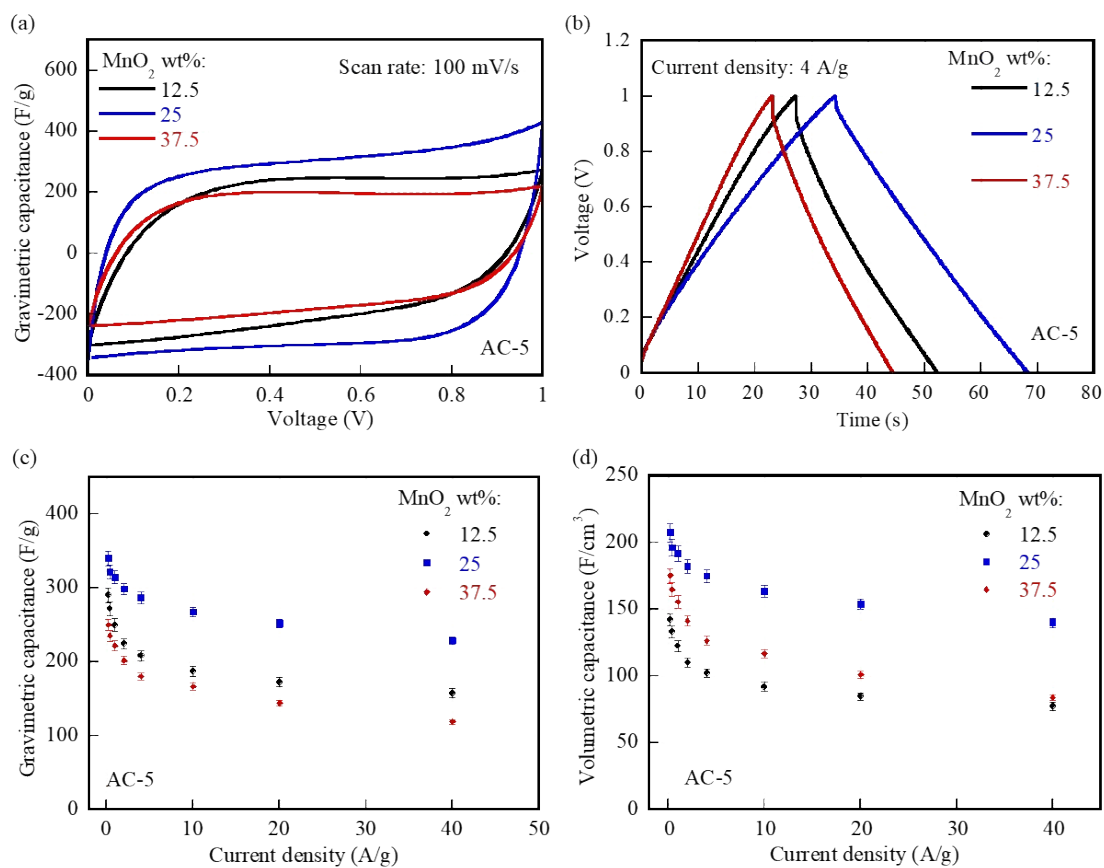


Figure S6. Electrochemical performances of SCs based on the composite of AC-5 and MnO₂ in different mass ratios: (a) CV curves at 100 mV/s, (b) GCD curves at 4 A/g, (c) variation of gravimetric capacitance with current density, and (d) variation of volumetric capacitance with current density.

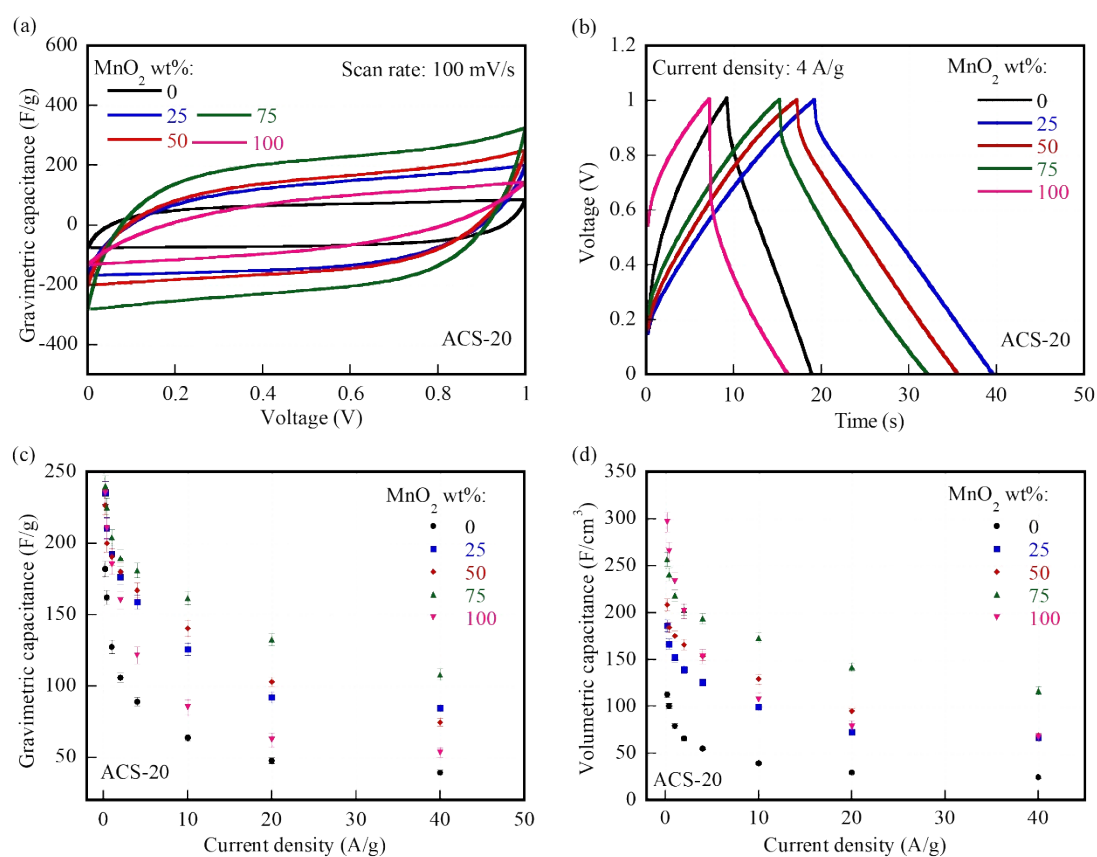


Figure S7. Electrochemical performances of SCs based on the composite of ACS-20 and MnO_2 in different mass ratios: (a) CV curves at 100 mV/s, (b) GCD curves at 4 A/g, (c) variation of gravimetric capacitance with current density, and (d) variation of volumetric capacitance with current density.

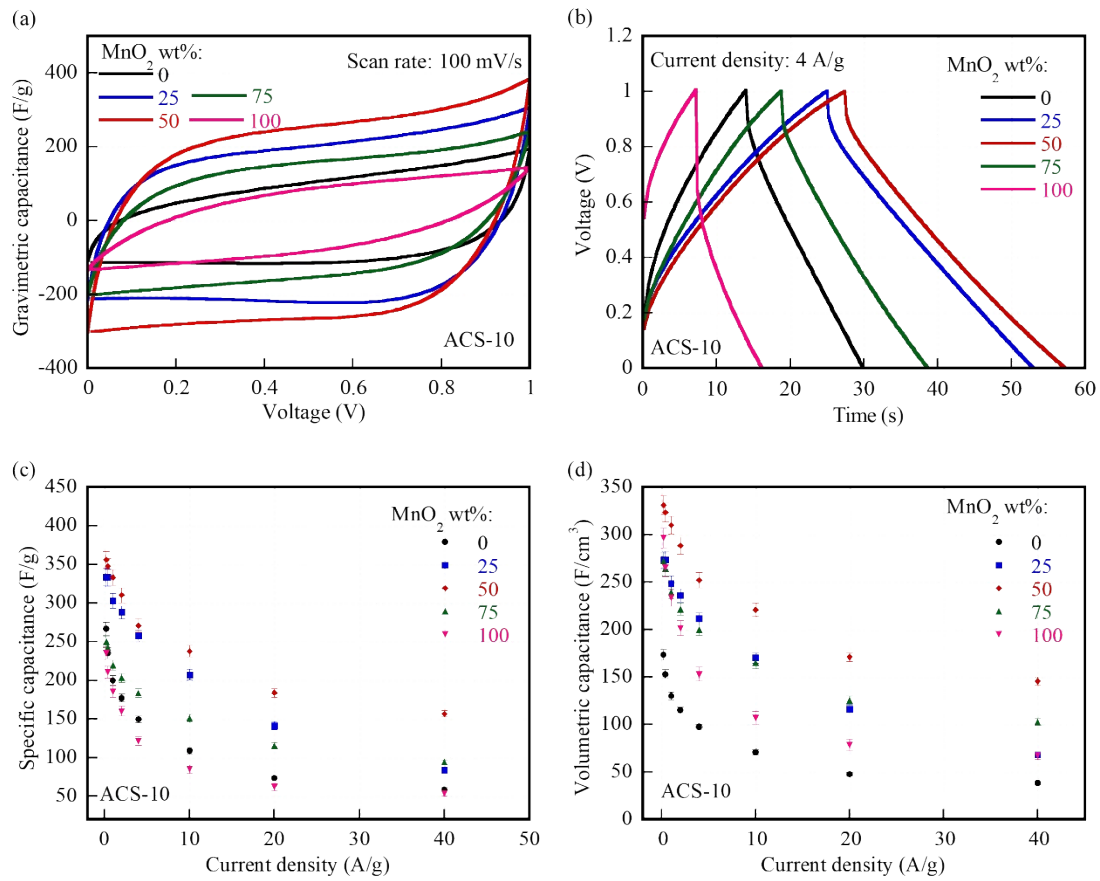


Figure S8. Electrochemical performances of SCs based on the composite of ACS-10 and MnO_2 in different mass ratios: (a) CV curves at 100 mV/s, (b) GCD curves at 4 A/g, (c) variation of gravimetric capacitance with current density, and (d) variation of volumetric capacitance with current density.

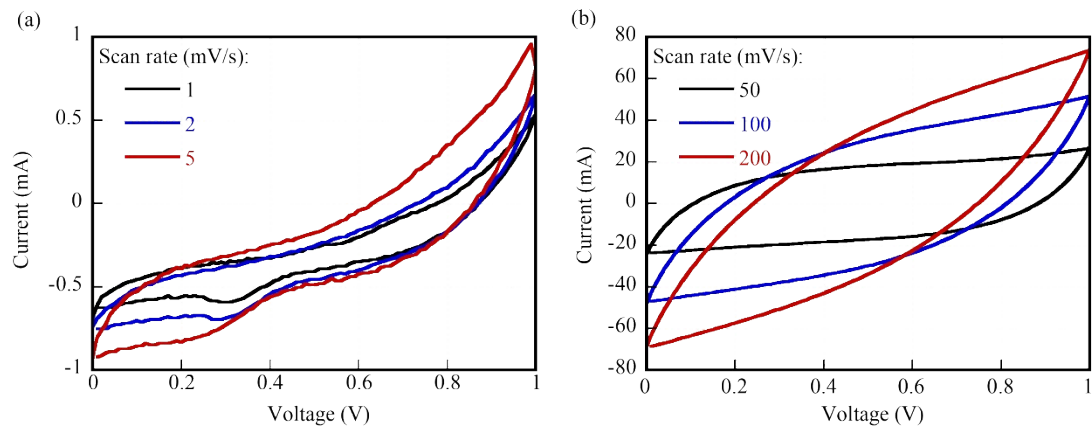


Figure S9. CV curves at low (a) and high (b) scan rates for SCs with MnO₂ as electrode.

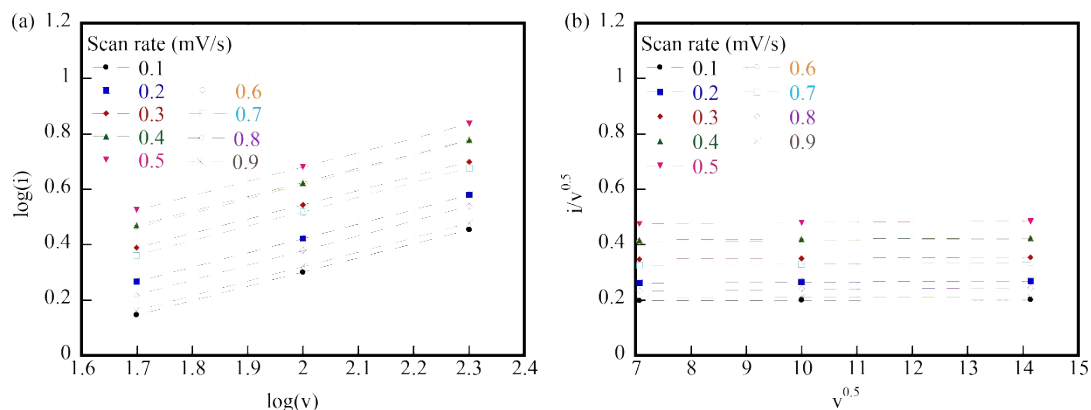


Figure S10. Representative fittings for the Dunn analysis of the MnO₂ electrode at various voltages for a scan rate of 50-200 mV/s: (a) Plot of $\log(i)$ versus $\log(v)$ for determining the b -value and (b) Plot of $i/v^{0.5}$ versus $v^{0.5}$ for quantifying the capacitive (k_1) and diffusion-controlled (k_2) currents.

Table S1. Dunn's Analysis (50-200 mV/s) at a scan rate of 100 mV/s for MnO₂

Voltage (V)	b -value	R^2 (b -value)	k_1	k_2	Capacitive Contribution (%)	Diffusion Contribution (%)	R^2 (k_1/k_2)
0.1	0.545	0.998	0.00035	0.195	1.8	98.2	0.980
0.2	0.520	0.999	0.00065	0.257	2.5	97.5	0.986
0.3	0.515	0.999	0.00064	0.342	1.9	98.1	0.998
0.4	0.512	0.999	0.00063	0.413	1.5	98.5	0.999
0.5	0.517	0.999	0.00086	0.468	1.8	98.2	0.996
0.6	0.517	0.999	0.00096	0.403	2.4	97.6	0.999
0.7	0.523	0.999	0.00096	0.318	3.0	97.0	0.999
0.8	0.530	0.999	0.00095	0.226	4.2	95.8	0.997
0.9	0.548	0.998	0.0006	0.201	3.0	97.0	0.985
Average	0.525	-	0.00073	0.291	2.4	97.6	-

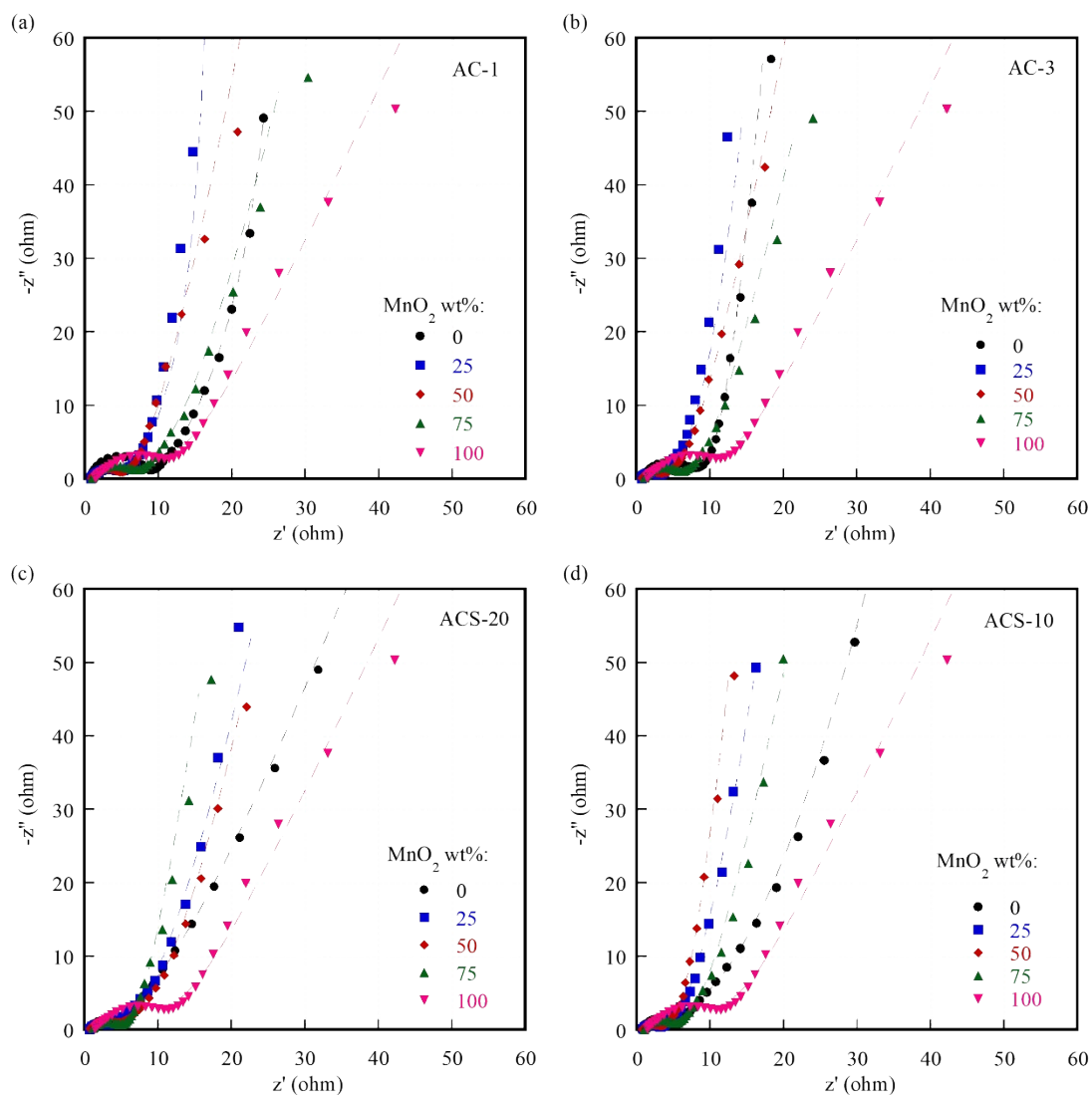


Figure S11. Nyquist plots of AC/MnO₂ hybrid electrodes in different MnO₂ mass ratios for: (a) AC-1, (b) AC-3, (c) ACS-20 and (d) ACS-10.

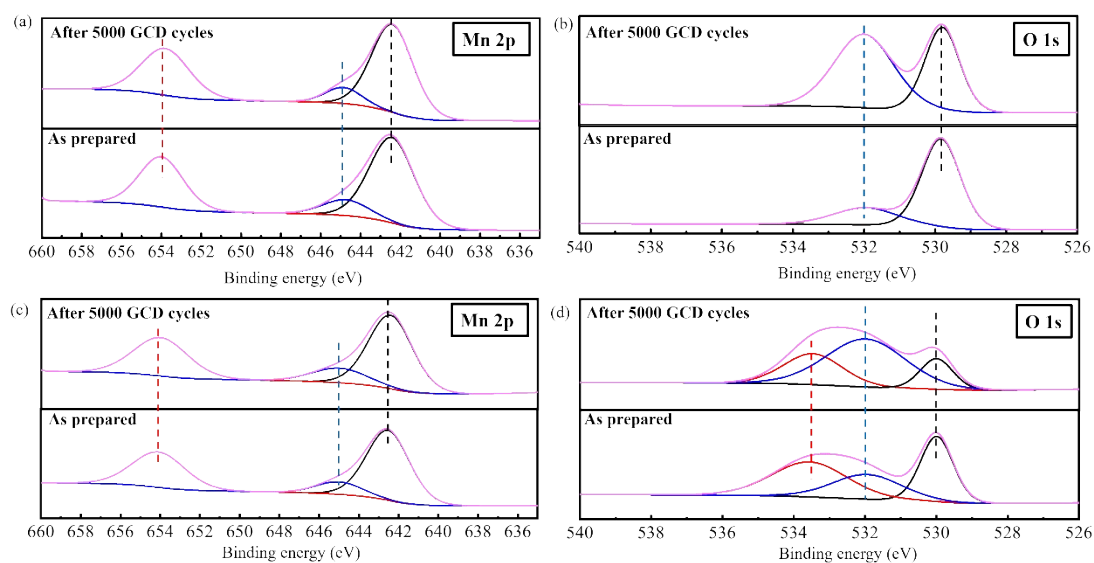
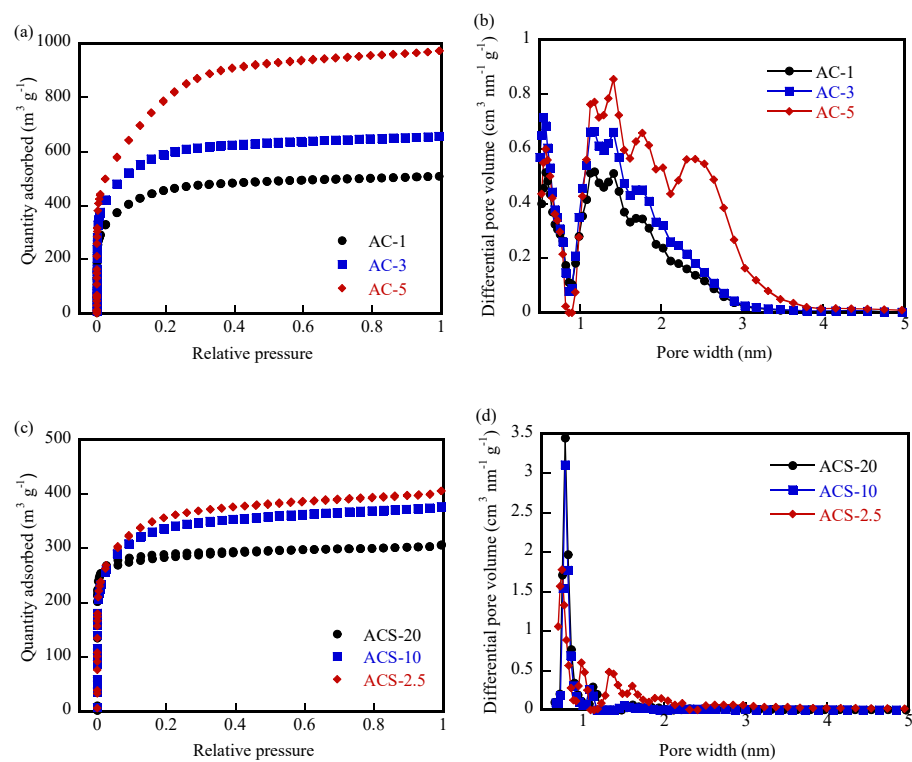
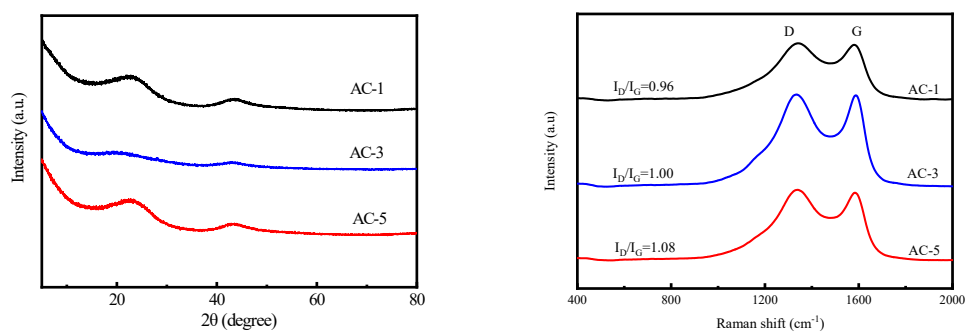


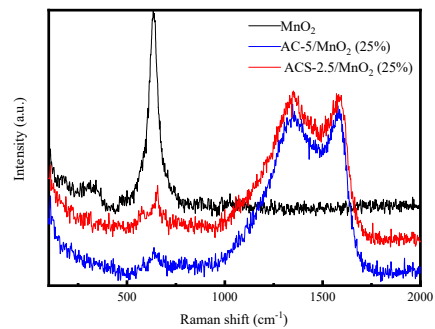
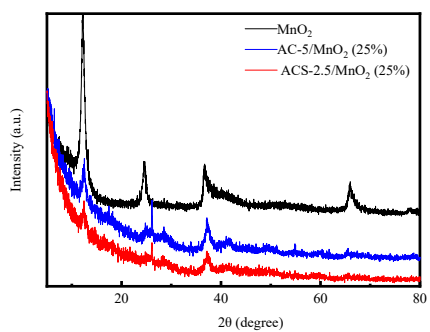
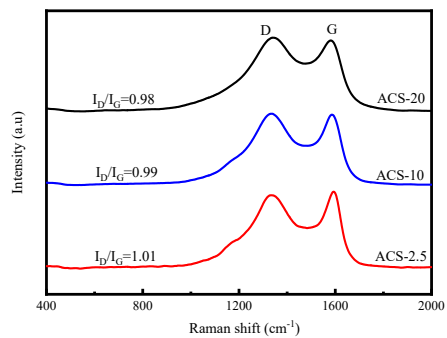
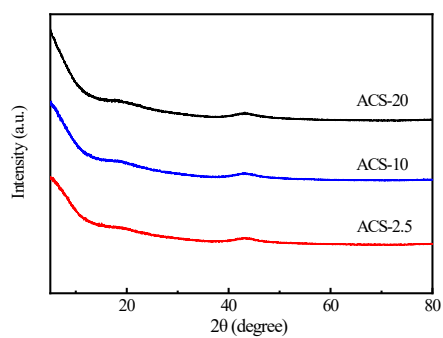
Figure S12. XPS analysis of electrodes before and after 5000 cycles: (a) Mn 2p spectra of pure MnO₂ electrode, (b) O 1s spectra of pure MnO₂ electrode, (c) Mn 2p spectra of ACS-2.5/25% MnO₂ composite electrode, (d) O 1s spectra of ACS-2.5/25% MnO₂ composite electrode.

Data



N_2 adsorption-desorption isotherms for: (a) Lamellar ACs and (c) ACSs; pore width distribution for (b) lamellar ACs and (d) ACSs.





XRD patterns and Raman spectra.