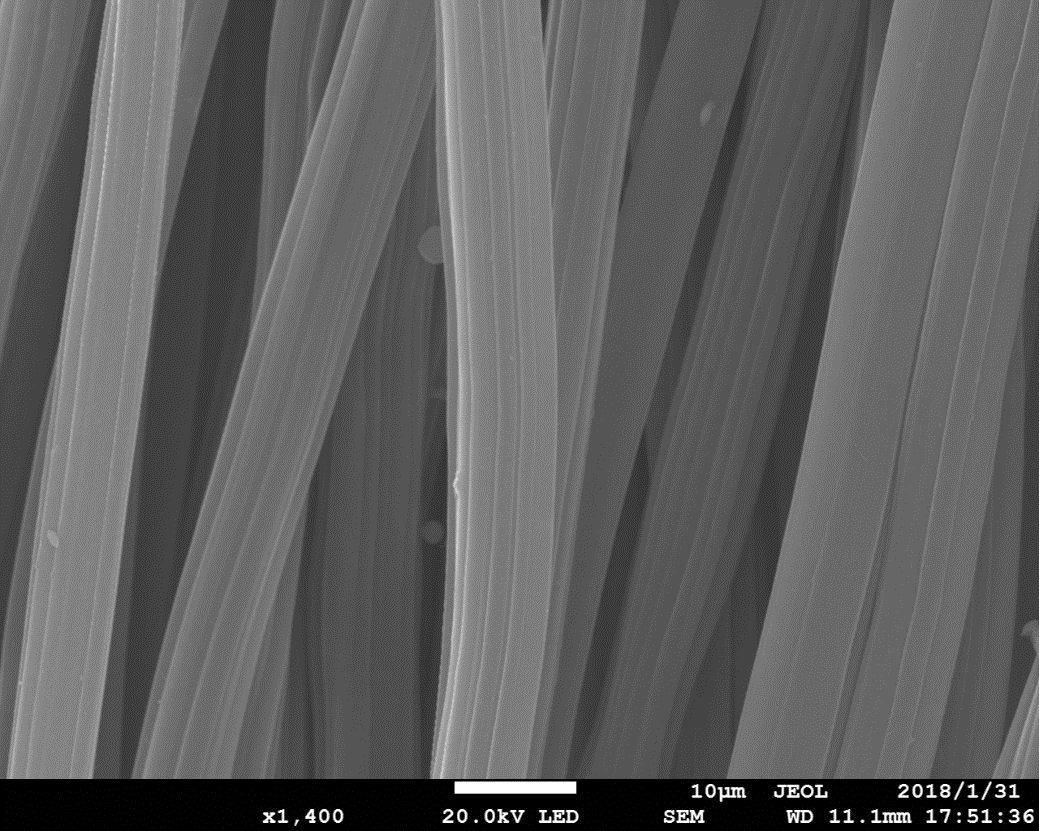
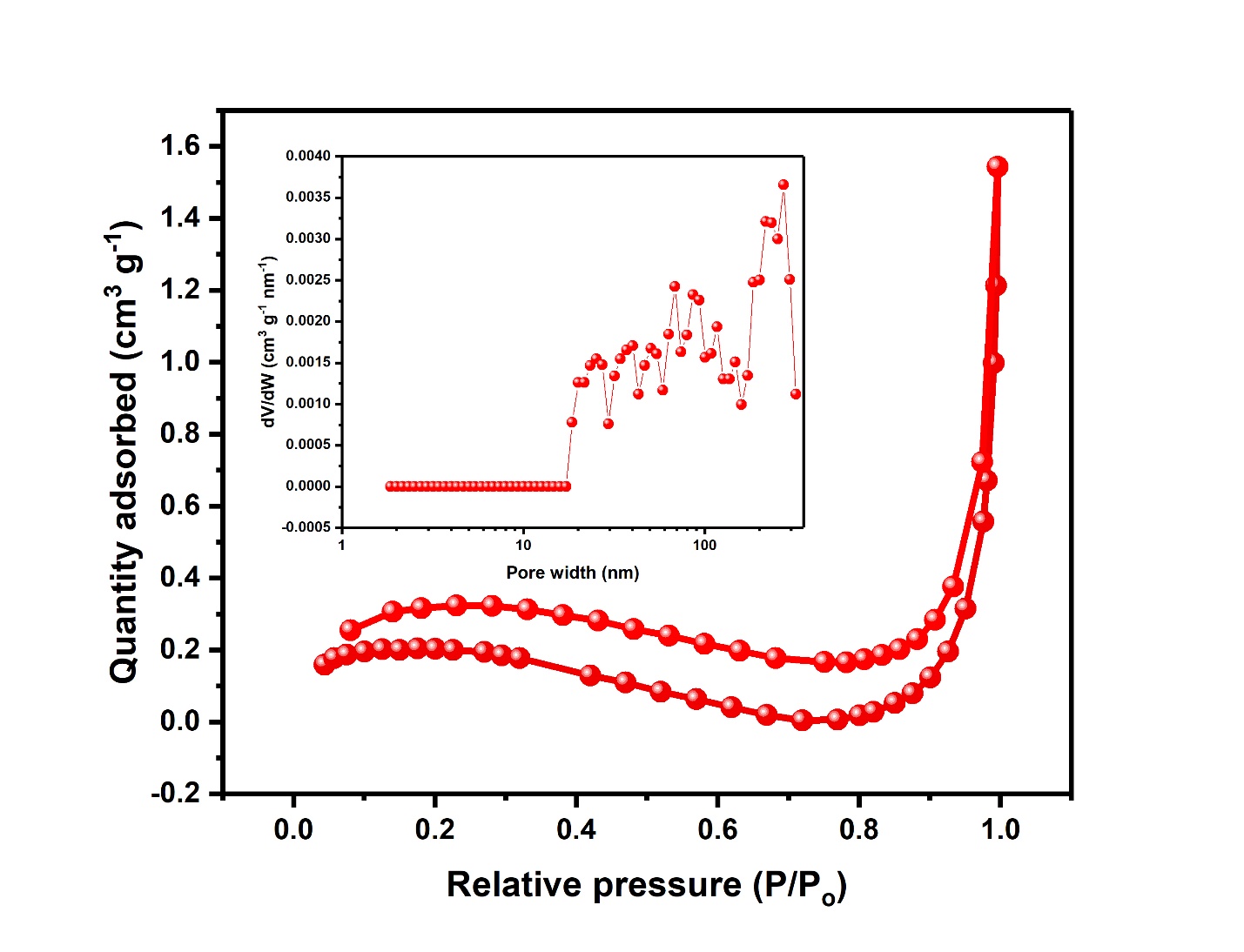
**Introducing Na2SO4 in aqueous ZnSO4 electrolyte realizes superior electrochemical performance in zinc-ion hybrid capacitor**

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1. **Supplementary figures**



**Figure S1.** SEM image of the pristine CC.



**Figure S2.** N2 adsorption-desorption curve of the pristine CC (Inset: pore-size distribution of the untreated CC).



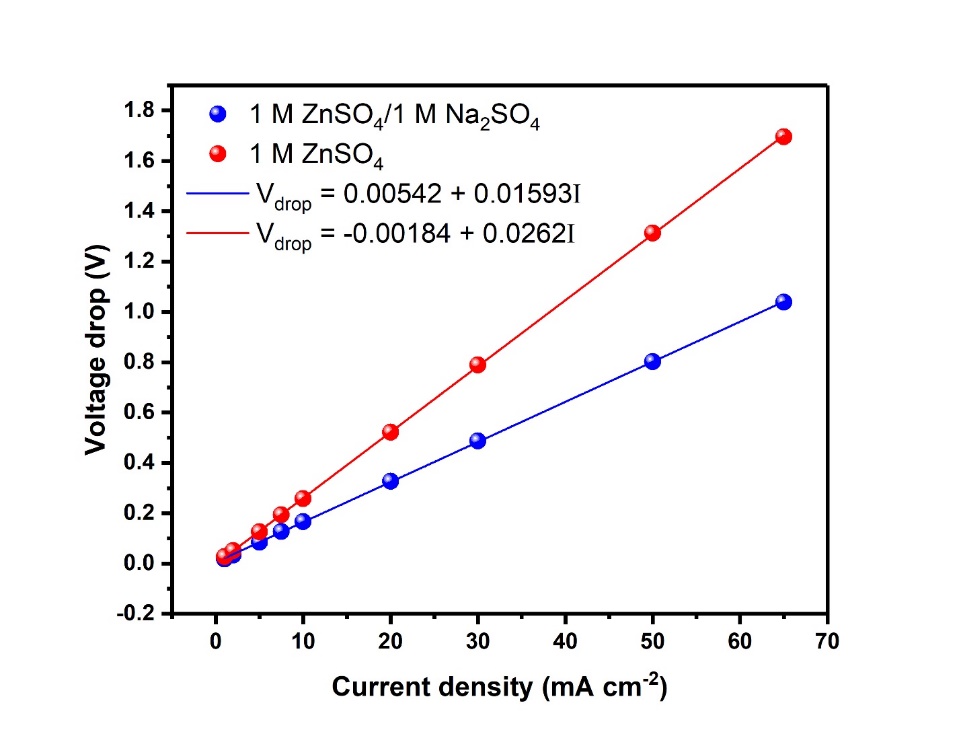
**Figure S3.** XPS survey spectrum of the ACC



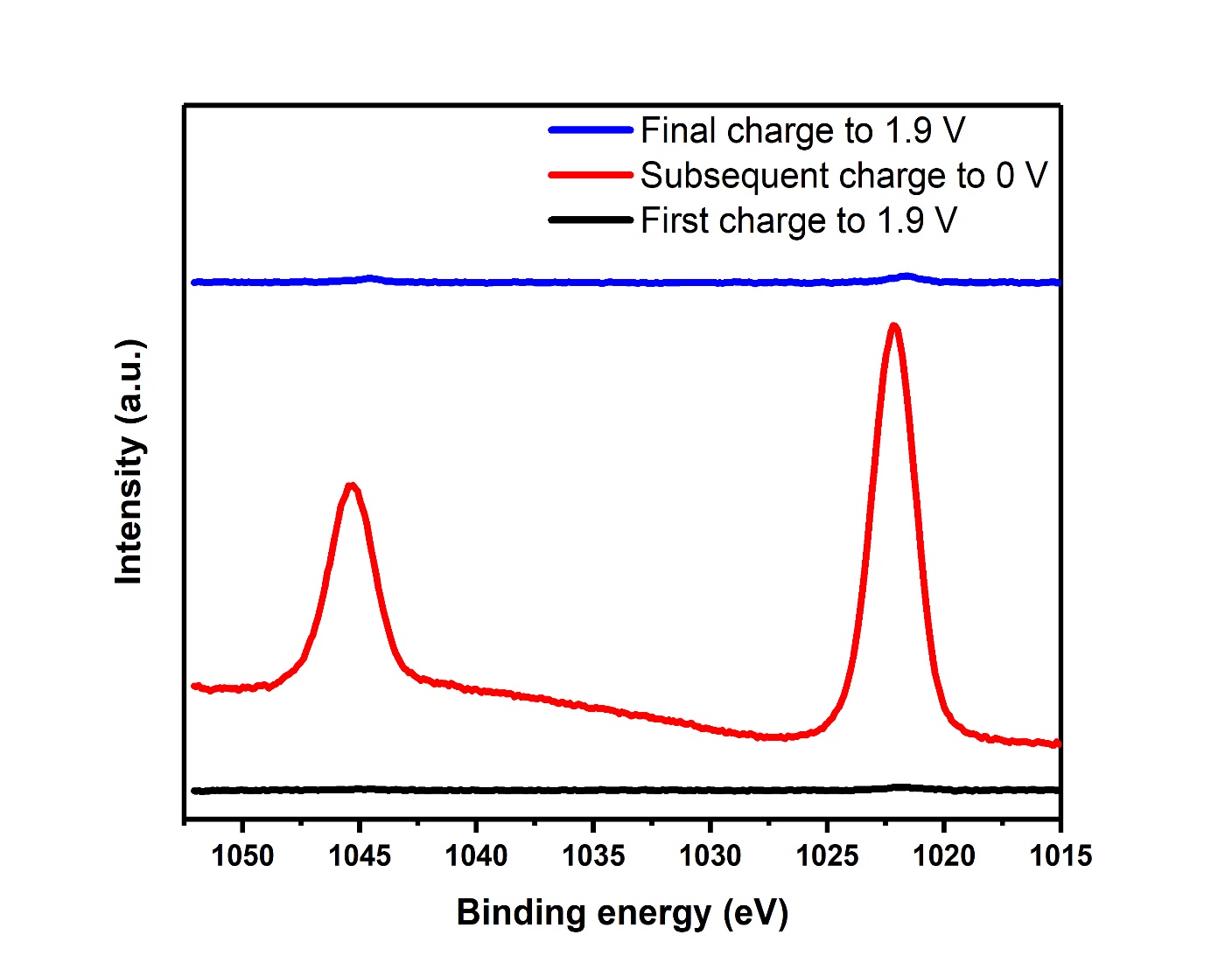
**Figure S4.** (a) Cyclic voltammetry (CV) curves of the ACC//Zn ZIHC using different combinations of the Na2SO4 and ZnSO4 electrolytes. (b) Rate capability of the ACC//Zn ZIHC using different combinations of the Na2SO4 and ZnSO4 electrolytes. (c) EIS Nyquist plots of the ACC//Zn ZIHC device using different combinations of Na2SO4 and ZnSO4 electrolytes.



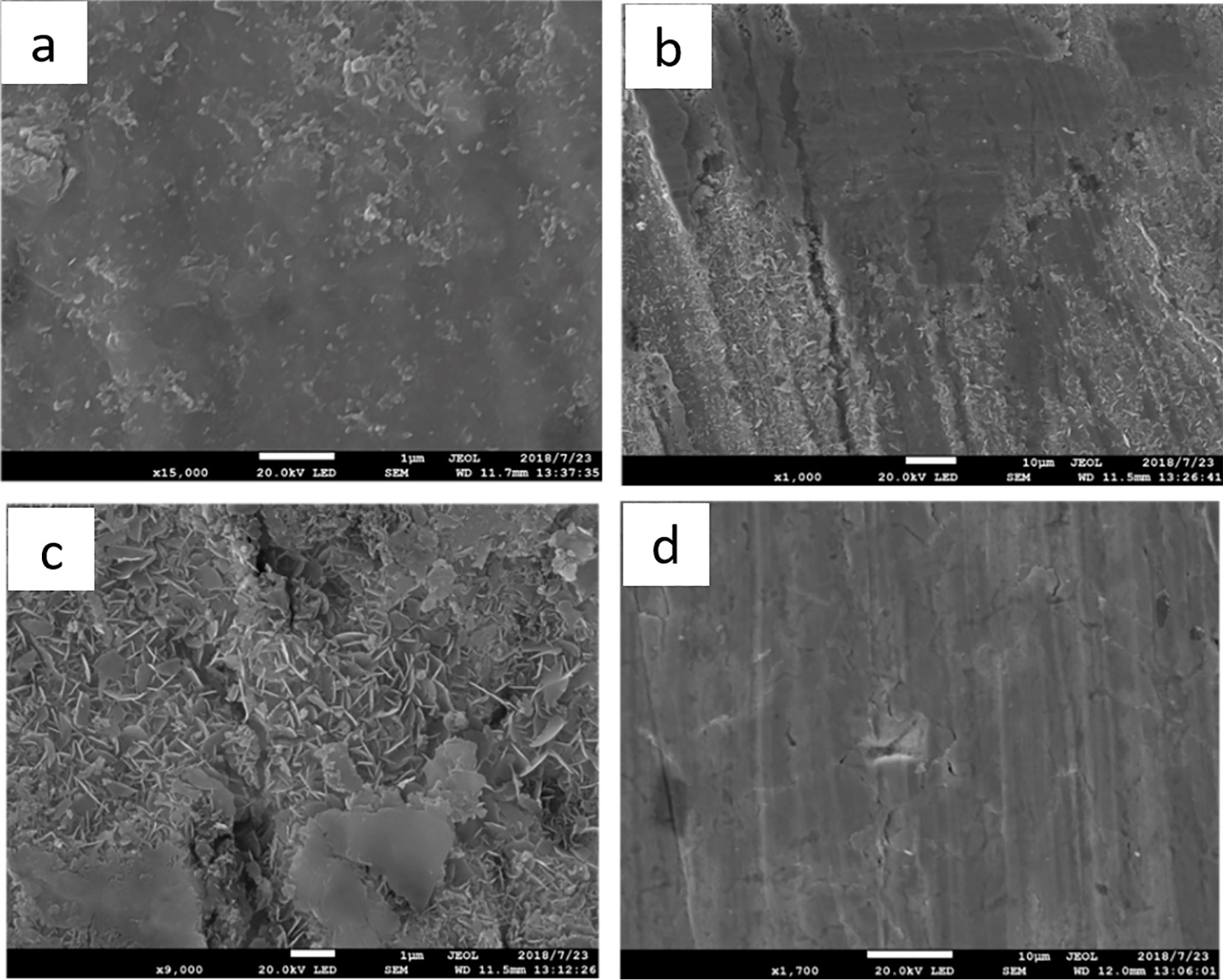
**Figure S5.** Cyclic voltammetry curves of the ZIHC using (a) 1 M ZnSO4 and (b) 1 M ZnSO4/1 M Na2SO4 electrolyte.



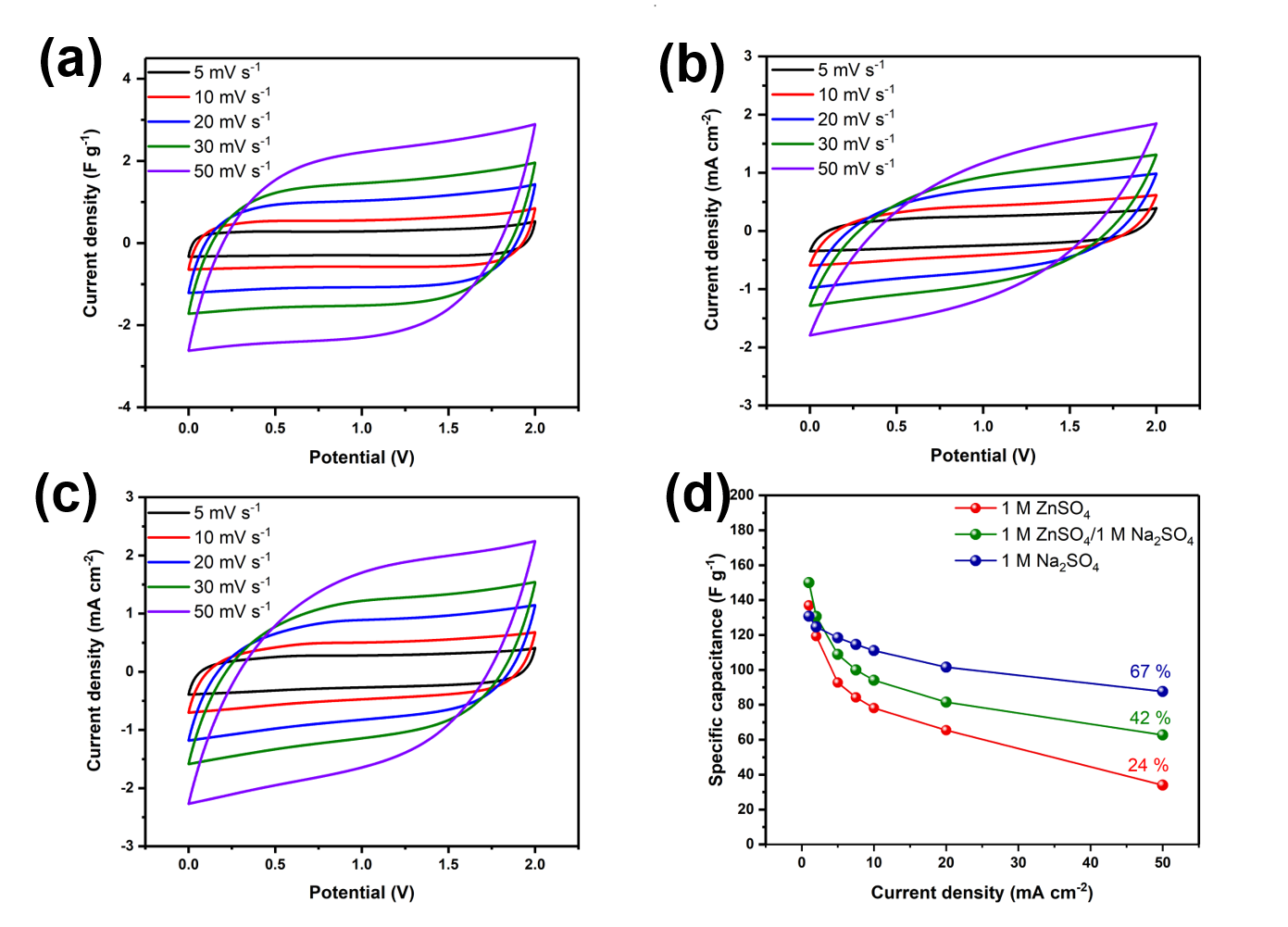
**Figure S6.** Comparison of the voltage drops at different current densities of the ZIHCs in 1 M ZnSO4 and 1 M ZnSO4/1 M Na2SO4 electrolyte.



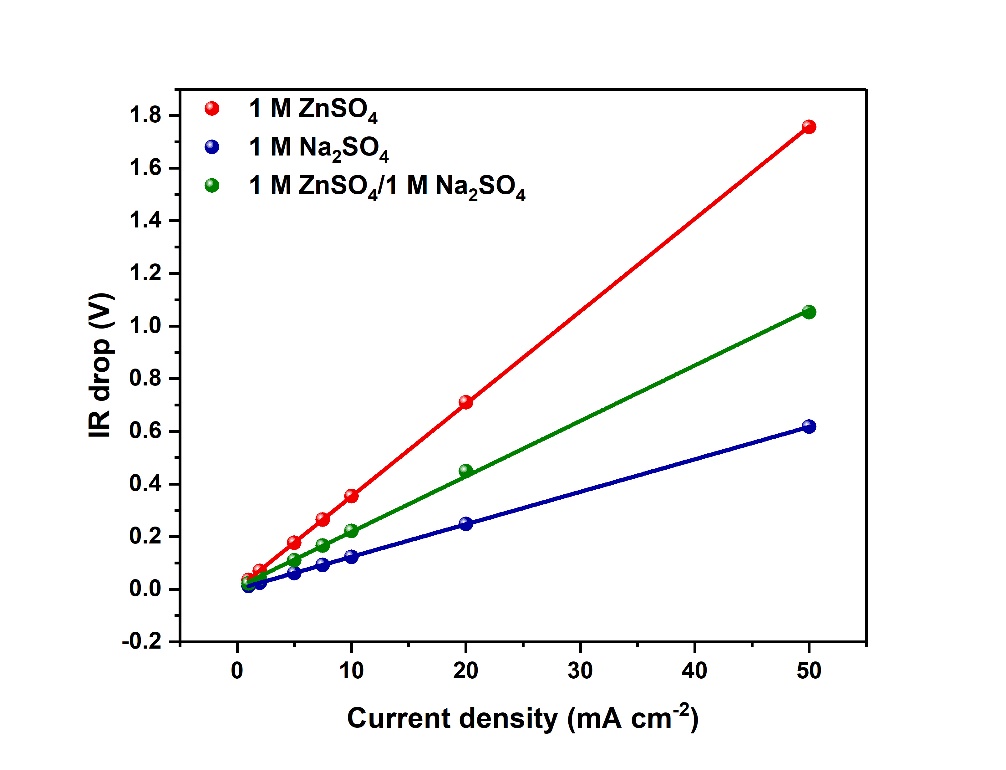
**Figure S7.** Zn 2p XPS signal at first charge (charge to 1.9 V), discharge to 0 V and final charge to 1. 9 V.



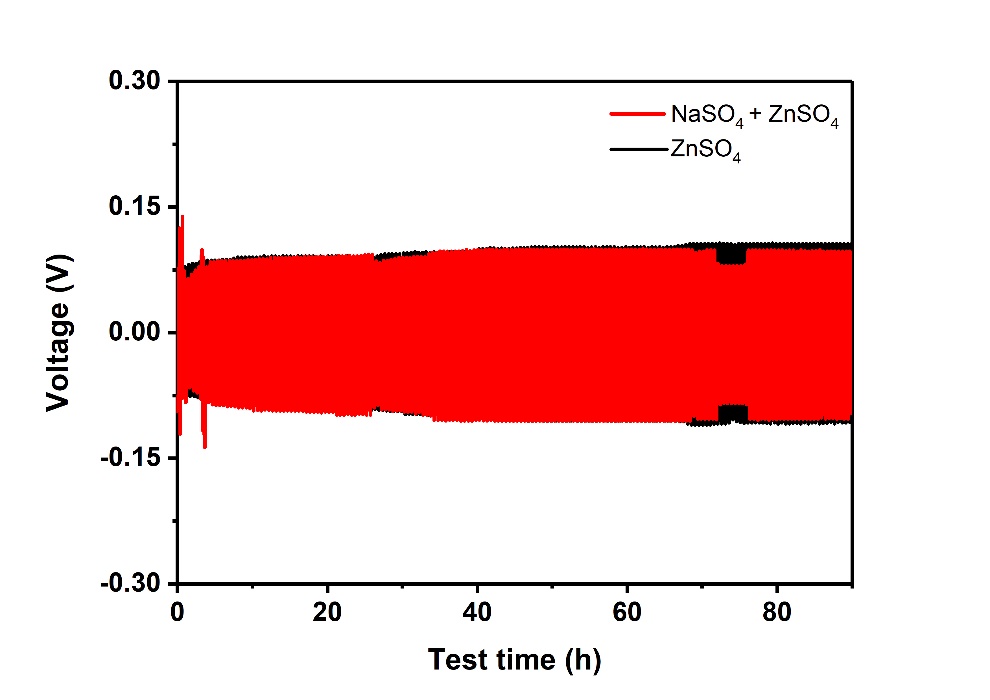
**Figure S8.** SEM images at (a) charge to 1.9 V (b) discharge from 1.9 V to 1.0 V (c) discharge to 0 V and (d) final charge to 1.9 V.



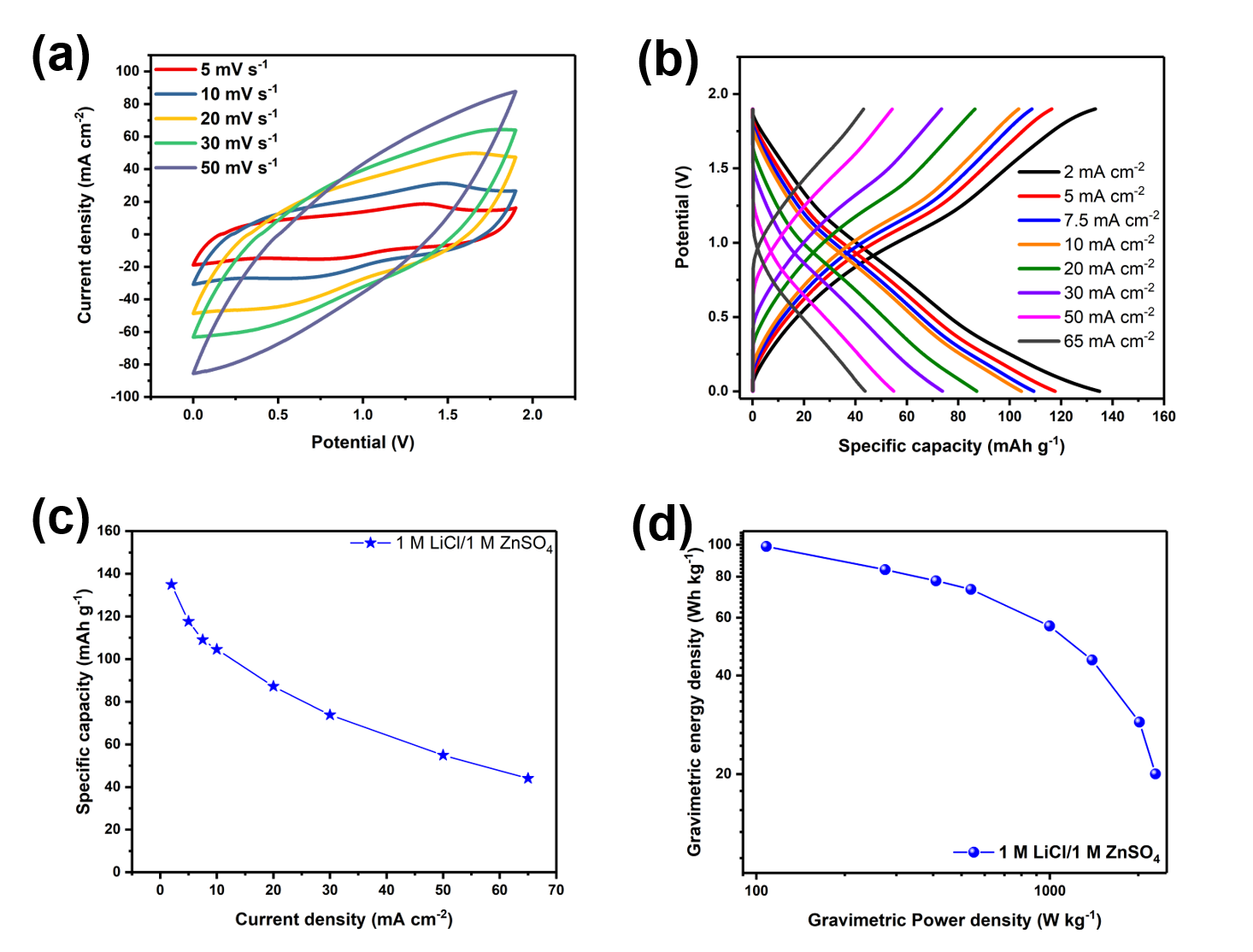
**Figure S9.** (a) Cyclic voltammetry curves of the ACC symmetric supercapacitor fabricated with 1 M Na2SO4. (b) Cyclic voltammetry curves of the ACC symmetric supercapacitor fabricated with 1 M ZnSO4 electrolyte. (c) Cyclic voltammetry curves of the ACC symmetric supercapacitor fabricated with 1 M ZnSO4/1 M Na2SO4 electrolyte. (c) Rate capability of the ACC electrodes in the different electrolytes.



**Figure S10.** Comparison of the voltage drops at different current densities of the carbon symmetric supercapacitor device in 1 M ZnSO4, 1 M Na2SO4 and 1 M ZnSO4/1 M Na2SO4 electrolyte.



**Figure S11.** Typical GCD curves of symmetric cells with 1 M ZnSO4 electrolyte (black) and 1 M ZnSO4/1 M Na2SO4 at a current density of 0.5 mA cm-2.



**Figure S12. (**a) Cyclic voltammetry curves of the Zn-ion HSC using 1 M LiCl/1 M ZnSO4 electrolyte. (b) Charge discharge curves of the Zn-ion HSC using 1 M LiCl/ 1 M ZnSO4 electrolyte. (c) Specific capacity of the ZIHC using 1 M LiCl/1 M ZnSO4 electrolyte. (d) Gravimetric energy and power density of the ZIHC using 1 M LiCl/1 M ZnSO4 electrolyte.

**Table S1**. Comparison of the ionic conductivities of the different zinc and sodium sulphate electrolyte combinations.

|  |  |
| --- | --- |
| Electrolyte | Ionic Conductivity (S cm-1) |
| 1 M ZnSO4 electrolyte  1 M Na2SO4 electrolyte  1 M ZnSO4/1 M Na2SO4 electrolyte  0.25 ZnSO4/0.75 M Na2SO4 electrolyte  0.5 M ZnSO4/0.5 M Na2SO4 electrolyte  0.75 M ZnSO4/0.25 M Na2SO4 electrolyte | 0.11  0.607  0.483  0.419  0.376  0.348 |

**Table S2.** Comparison of the performance of this work with some reported ZIHC devices

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Zinc-Ion Hybrid Capacitor (ZIHC) | Specific capacity  (mAh g-1) | Cell Voltage  (V) | Energy Density (Wh kg-1) | Cycling Performance |
| MnO2/ZnSO4/Zn[1] | **54.1** | 2 V | 34.8 | 65.3 % after 3000 cycles |
| AC/Zn(CF3SO3)2/Zn[2] | **170 F g-1** | 1.8 V | 52.7 | 91 % after 20000 cycles |
| HCS/ZnSO4/Zn[3] | **86.8** | 1.8 V | 59.7 | 98 % after 15000 cycles |
| ACC/ZnSO4/Zn[4] | **318 F g-1** | 1.6 V | 94 | 99.2 % after 10000 cycles |
| HNPC/ZnSO4/Zn[5] | **177.8** | 1.8 V | 107.3 | 99.7 % after 20000 cycles |
| HPC/ZnSO4/Zn[6] | **305** | 1.8 V | 118 | 94.9 % after 20000 cycles |
| ACC/ZnSO4/Na2SO4/Zn [this work] | **154** | 1.9 | 100 | Stable cycling up to 20000 cycles |

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