Thermal Encapsulated Phenothiazine@MWCNTs Cathode for Aqueous Zinc Ion Battery

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Supplementary Information

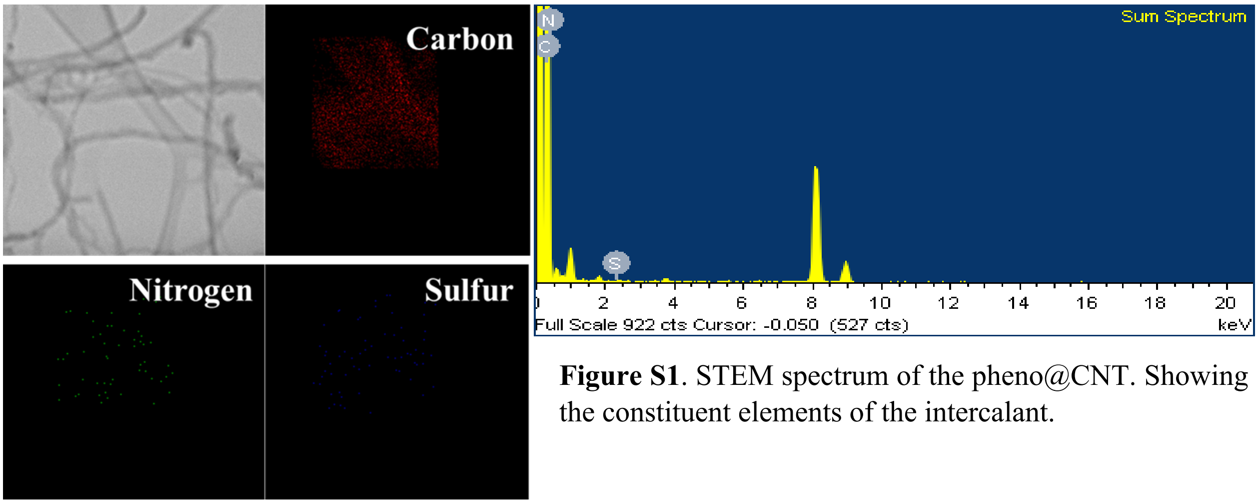


Figure S1. STEM spectrum of the pheno@CNT. Showing the constituent elements of the intercalant.

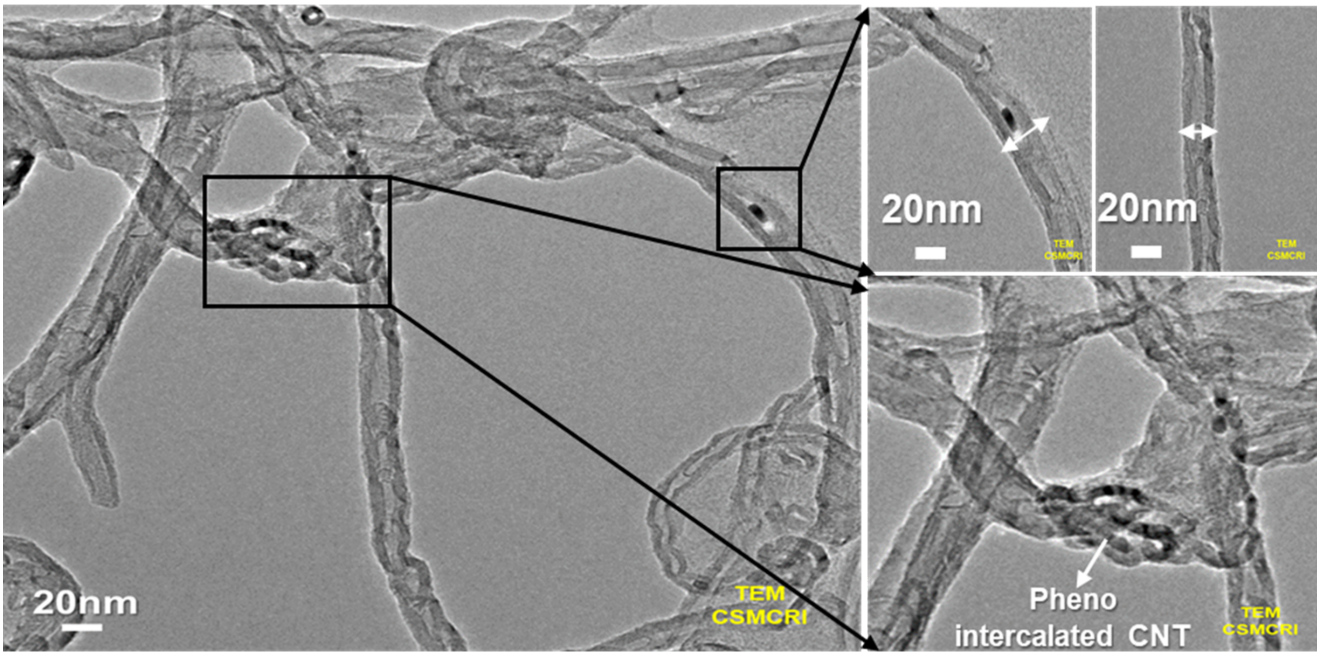


Figure S2. HRTEM images of the intercalated material.

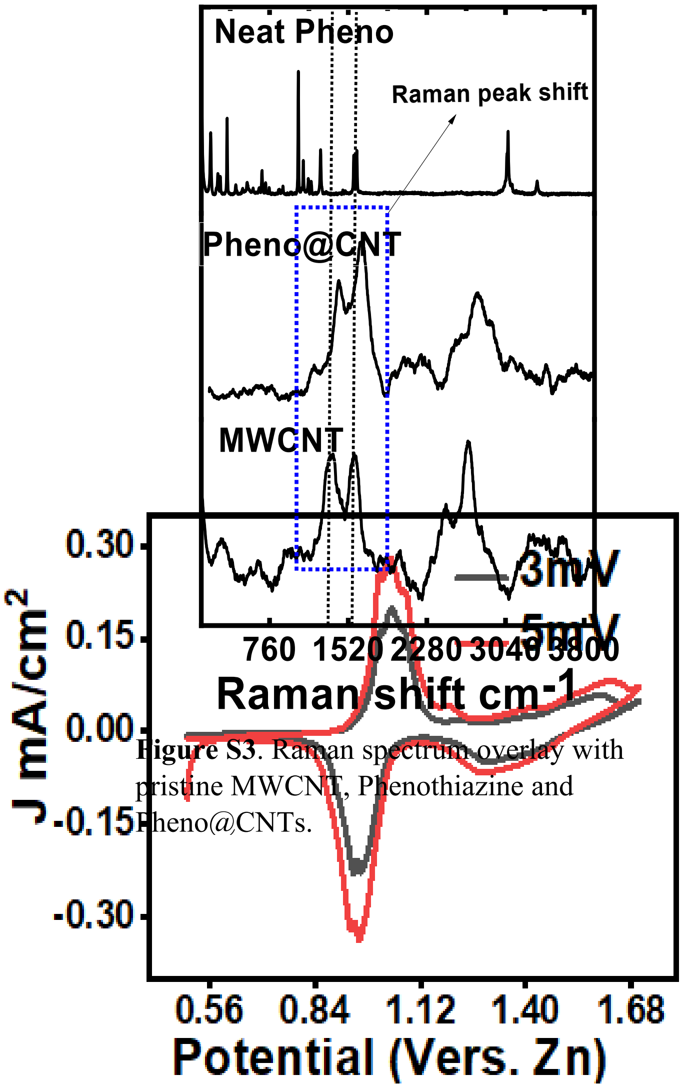


Figure S3. Raman spectrum overlay with pristine MWCNT, Phenothiazine and Pheno@CNTs.

Figure S4. Voltammogram of neat phenothiazine versus zinc plate in 2M $ZnSO_4$ at slow scan rate showing reversibility of the electrode.

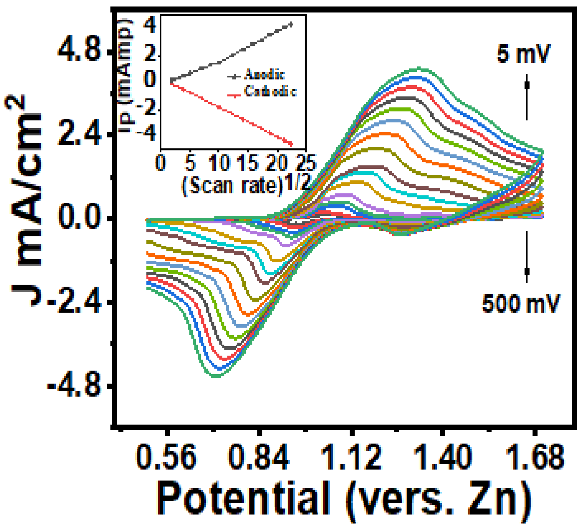


Figure S5. Voltammogram of neat phenothiazine versus zinc plate in 2M $ZnSO_4$ at different scan rate. Inset dependence of current vs square root of scan rate.

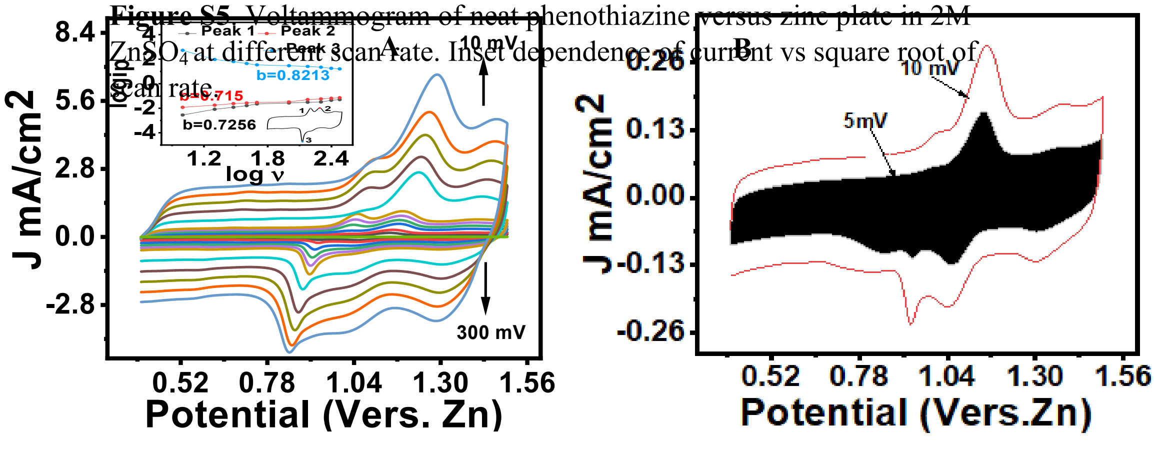
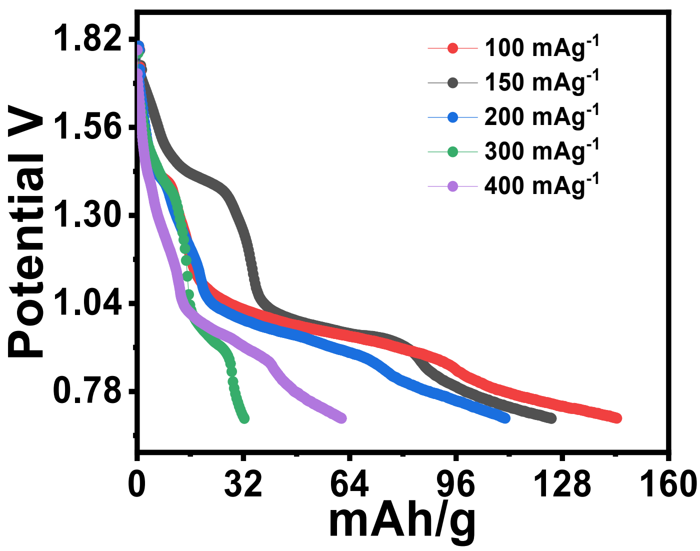


Figure S6. A) Voltammogram of Pheno@CNT at different scan rate 10-300 $mVSec^{-1}$, inset plot of log i_p versus logν, B) Voltammogram at slow scan rate. (Versus Zn in 2M $ZnSO_4$ solution).



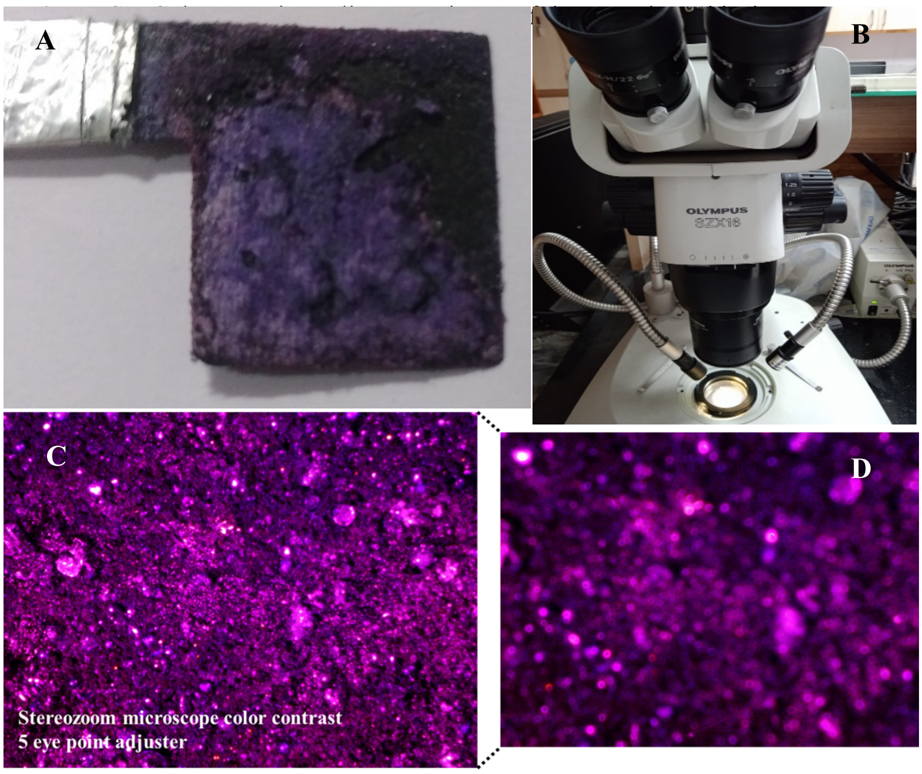


Figure S8. A) shows the surface genuine color of the electrode after cycling experiment, fully charged. B) shows the visual image of the optical microscope with magnifying lenses, illuminators, stereo zoom adjuster and camera. C&D) The electrode surface under stereozoom optical microscope. maximized color contrast image where the coral like structures were visible.

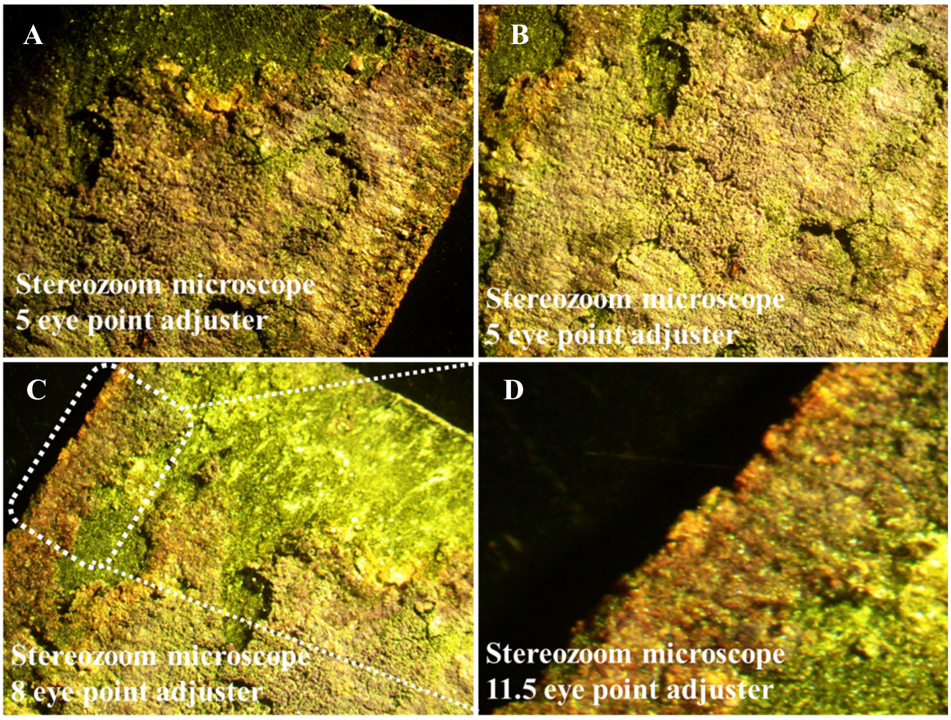


Figure S9. Optical stereo zoom microscopic images of cathode surface at different eye point zoom adjuster.

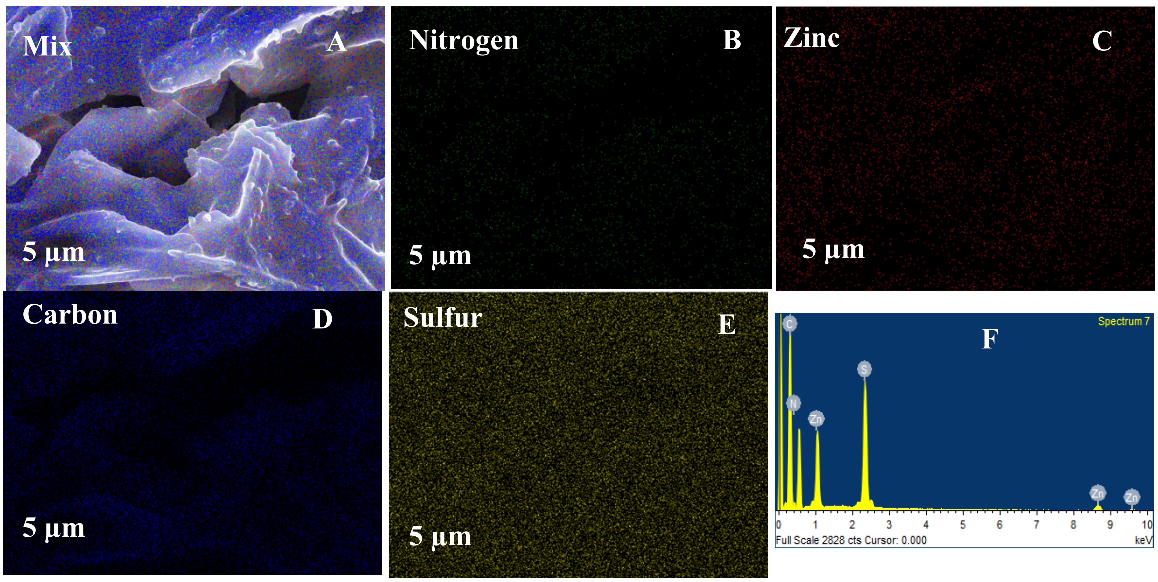


Figure S10. Shows the EDX elemental mapping of the cathode with neat phenothiazine. A) Mix, B) Nitrogen, C) Zinc, D) Carbon, E) Sulfur, F) EDX elemental mapping spectrum of the cathode.

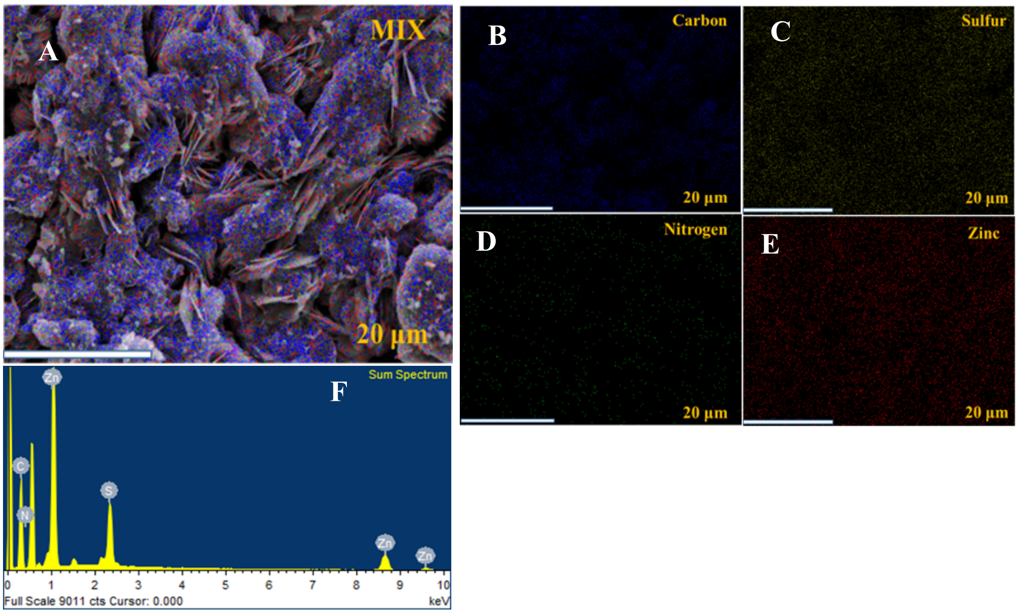


Figure S11. Shows the EDX elemental mapping of the cathode with pheno@CNT after cycling experiment. A) Mix, B) Carbon, C) Sulfur, D) Nitrogen, E) Zinc F) EDX spectrum. (The high amount of sulphur indicated the sulphate anion intercalation into the cathode).

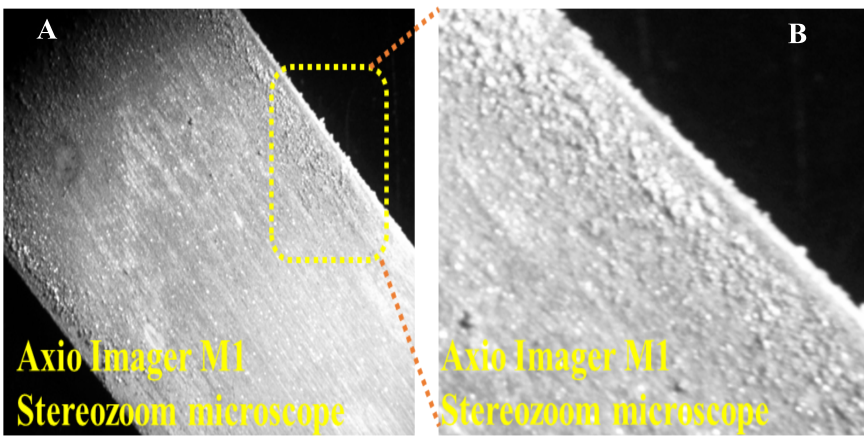
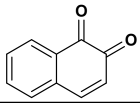
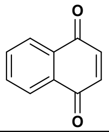
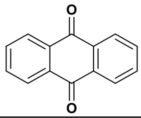
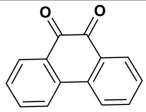
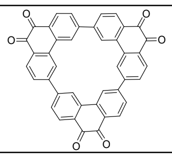
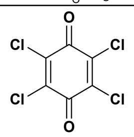
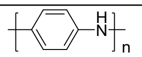
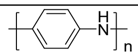
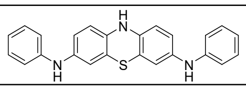
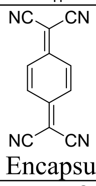
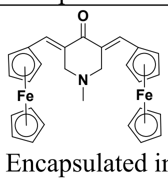
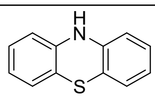


Figure S12. Stereozoom optical microscopic images of anode at zoom range A) 7x and B)11x.

Table S1 : Comparison of the data with the literature.

Se. No.	Cathode material	Operating voltage V	Electrolyte (Aqueous)	Charging / Discharging capacitance MAh/g (current density mA/g)	Coulombic efficiency %	No.of electrons involved	Mechanism	Reference
1		0.5-1.28	3M $Zn(CF_3SO_3)_2$ Aqueous	68	55 after 5 cycles	2	Phase reaction-coordination	1
2		0.2-1.7	3M $Zn(CF_3SO_3)_2$ Aqueous	149 (20)	46 after 5 cycles	2	Phase reaction-coordination	
3		0.2-1.8	3M $Zn(CF_3SO_3)_2$ Aqueous	194 (20)	124 after 40 cycles	2	Phase reaction-coordination	
4		0.2-1.8	3M $Zn(CF_3SO_3)_2$ Aqueous	111(20)	88 after 5 cycles	2	Phase reaction-coordination	
5		0.25–1.6	3M $(ZnCF_3SO_3)_2$	210 mAhg−1 at 150 mA g−1	99% after 500 cycles	6 electrons	Coordination	2
6		0.8-1.4	1M $Zn(CF_3SO_3)_2$ Aqueous	170 (0.2C) 118 (1C)	90 after 100 cycles 0.2C, 83 after 200 cycles 0.2C	2	Water assisted phase transfer (encapsulate in to porous carbon)	3
7	 PANI coated carbon fiber	0.5-1.5	1M $Zn(CF_3SO_3)_2$	200 dischargin g(0.05Ag-1)	92% after 3000 cycles	1	insertion/extract ion and dual-ion	4
8		0.7-1.7	1 M $ZnCl_2$	165 (1C)	98% 52 cycles	1	Dual ion	5
9		0.1-1.8	2 M $ZnSO_4$	188.24 (40)	95%	2	p/n type hybrid	6
10	 Encapsulated in COF	0.4-1.6	1 M $ZnSO_4$	171 (1A)	100% 100 cycles	2	Coordination (n-type conjugated nitrile)	7
11	 Encapsulated in MWCNTs	0.2-1.8	2MZnSO4	71.3 (75)	94%	2	Anion insertion Dual ion	8
12	 **Thermal intercalation inside MWCNTs**	**0.6-1.8**	**2 M $ZnSO_4$**	**239.9**	**99% 2200 Cycles**	**2**	**P type- dual ion pairing**	**This work**

References

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