Electronic Supplementary Information

Perchlorate ions doped polypyrrole coated ZnS spheres composite as sodium-ion battery anode with superior rate capability enhanced by pseudocapacitance

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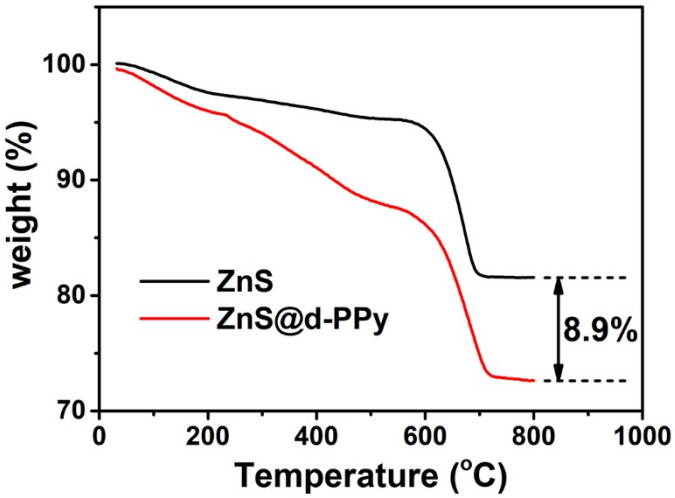

Fig. S1. TGA curves for ZnS and ZnS@d-PPy from room temperature to 800°C measured with a heating rate of 10°C min^{-1} under air atmosphere.

With temperature increasing, the final product of combustion is ZnO for both ZnS and ZnS@d-PPy. Two steps of weight losses in ZnS can be observed and assigned to the evaporation of absorbed water (before 300°C) and the oxidation of the ZnS (between 600 and 700°C). For ZnS@d-PPy, mass losses before 300°C are composed of the evaporation of adsorbed water for both ZnS and d-PPy.[1-3] The thermal decomposition of d-PPy can range in temperature from 300°C to 800°C and a rapid decrease in weight between 600 and 700°C is mainly assigned to the oxidation of ZnS in ZnS@d-PPy. Therefore, the content of d-PPy in ZnS@d-PPy can be obtained by weighting the final weights of ZnS and ZnS@d-PPy, which is about 8.9 wt%, as shown in Fig. S1.

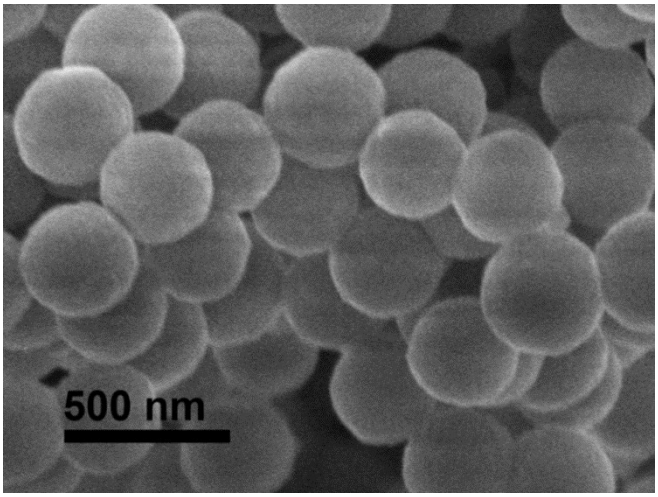

Fig. S2. SEM image of ZnS@PPy.

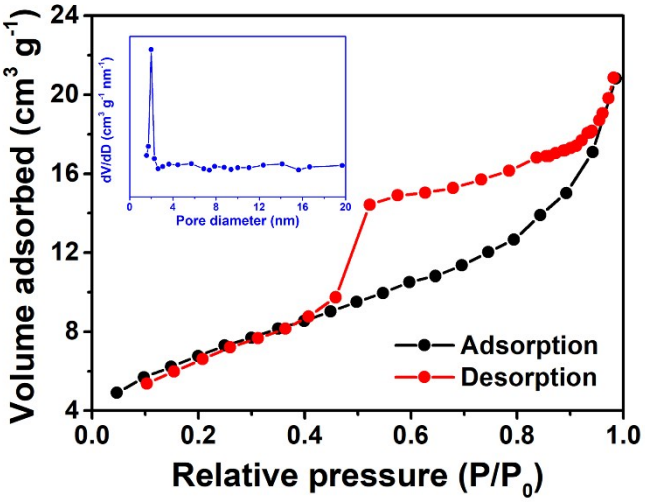

Fig. S3. Nitrogen sorption isotherm of ZnS. Inset of it is the pore size distribution curve.

Nitrogen sorption analysis of ZnS spheres shows type-IV curve and the mesopores are generated from nanoparticles stacking. The pore size distribution center at about 2 nm measured using Barrett-Joyner-Halenda (BJH) model. The Brunauer-Emmett-Teller (BET) surface area is calculated to be 24 m^2 g^{-1}.

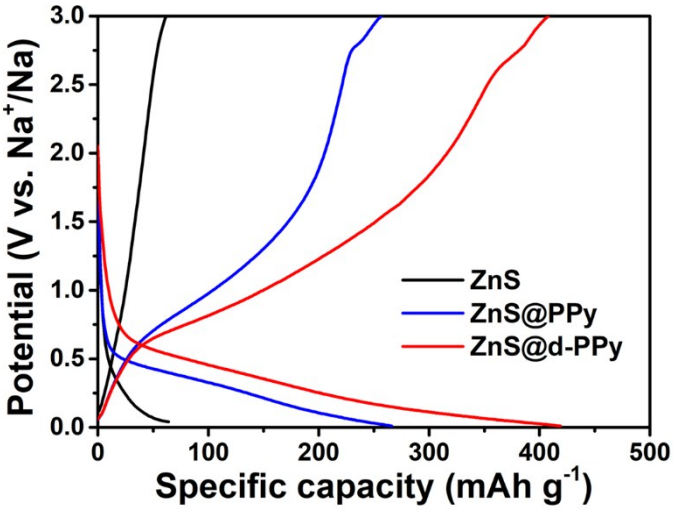

Fig. S4. Discharge/charge voltage profiles of ZnS, ZnS@PPy and ZnS@d-PPy between 0.01 and 3 V at 100 mA g^{-1} at the 30th cycle.

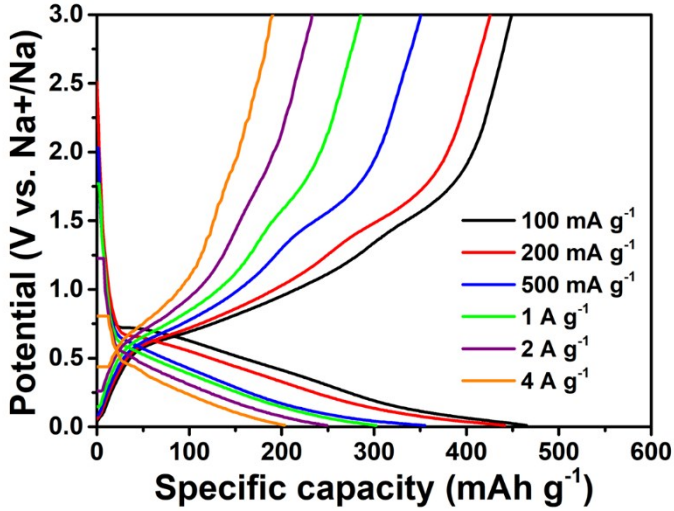

Fig. S5. Discharge/charge voltage profiles of ZnS@d-PPy between 0.01 and 3 V at different rates.

Table S1. Comparison of the results in this study with previous reported performance of the ZnS-based SIB anodes.

Sample	Rate capability	Cycling performance	reference
ZnS-RGO	610 mAh g^{-1} at 100 mA g^{-1}; 472 mAh g^{-1} at 250 mA g^{-1}; 417 mAh g^{-1} at 500 mA g^{-1}; 357 mAh g^{-1} at 1000 mA g^{-1};	481 mAh g^{-1} at 100 mA g^{-1} (50 cycles)	1
ZnS@NC	480 mAh g^{-1} at 100 mA g^{-1}; 450 mAh g^{-1} at 200 mA g^{-1}; 410 mAh g^{-1} at 500 mA g^{-1}; 360 mAh g^{-1} at 1000 mA g^{-1};	460 mAh g^{-1} at 200 mA g^{-1} (80 cycles)	2
ZnS	~850 mAh g^{-1} at 20 mA g^{-1}; ~670 mAh g^{-1} at 40 mA g^{-1}; ~600 mAh g^{-1} at 80 mA g^{-1}; ~560 mAh g^{-1} at 160 mA g^{-1}; ~500 mAh g^{-1} at 320 mA g^{-1}; ~460 mAh g^{-1} at 640 mA g^{-1};	465 mAh g^{-1} at 320 mA g^{-1} (100 cycles)	4
ZnS@d-PPy	465 mAh g^{-1} at 100 mA g^{-1}; 441 mAh g^{-1} at 200 mA g^{-1}; 355 mAh g^{-1} at 500 mA g^{-1}; 302 mAh g^{-1} at 1000 mA g^{-1}; 249 mAh g^{-1} at 2000 mA g^{-1}; 203 mAh g^{-1} at 4000 mA g^{-1};	419 mAh g^{-1} at 100 mA g^{-1} (30 cycles)	**This work**

References

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