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Supporting Information

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Mesoporous NiS_2 Nanospheres Anode with Pseudocapacitance for High-Rate and Long-Life Sodium-Ion Battery

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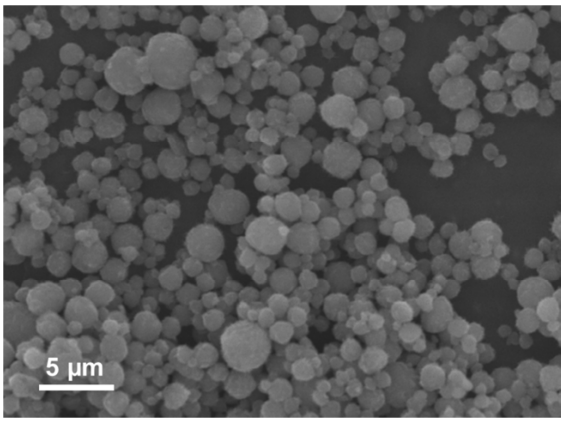

Figure S1. Low magnification SEM image of the NiS_2 without PVP.

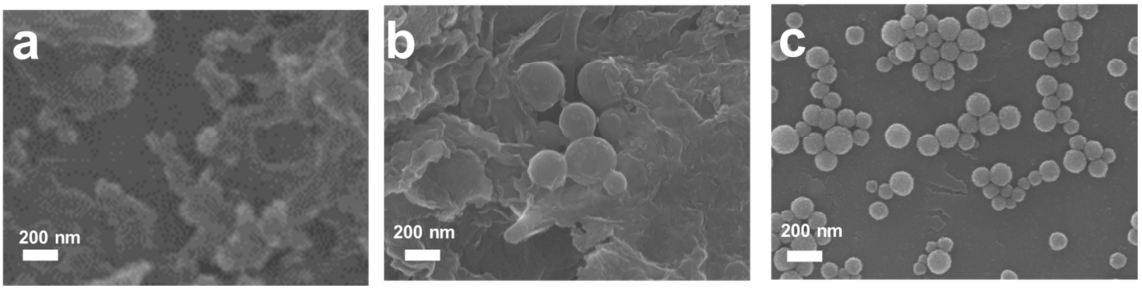

Figure S2. SEM images of the as-prepared NiS_2 nanospheres obtained at different reaction times. (a) 30min. (b) 50min. (c) 70min.

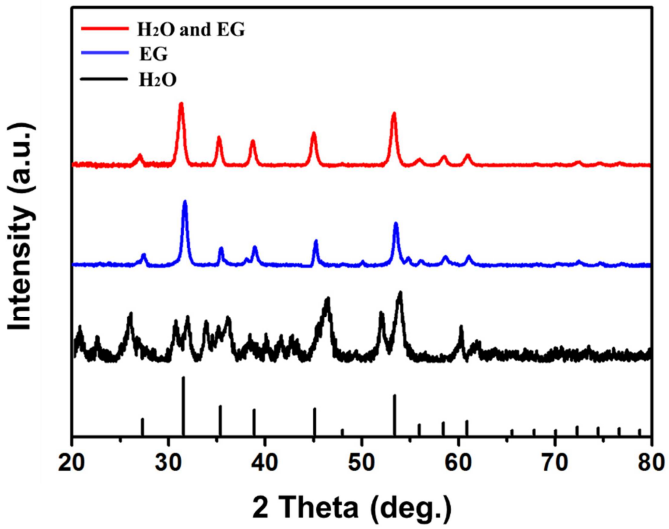

Figure S3. XRD patterns of the NiS_2 nanospheres obtained at different solvents.

S1. Formation mechanism analysis of mesoporous NiS_2 nanospheres.

The formation mechanism of mesoporous NiS_2 nanospheres should be a two - stage growth mechanism. The initial process is a nucleation process for primary particles, which follows the standard rapid nucleation theory.[1] When the solution becomes a supersaturated solution, resulting in the nucleation of NiS_2. The nucleation process of nickel sulfide can be described as the following four steps:[2,3]

$$OHCH_2CH_2OH \rightarrow CH_3CHO+H_2O \quad (1)$$

$$Ni^{2+} + CH_3CHO + 2H_2O \rightarrow CH_3CH_2OH + Ni^{4+} + 2OH^- \quad (2)$$

$$S_2O_3^{2-} + Ni^{4+} \rightarrow Ni(S_2O_3)_2 \quad (3)$$

$$Ni(S_2O_3)_2 + H_2O \rightarrow NiS_2 + H_2SO_4 \quad (4)$$

At high temperature, ethylene glycol is condensed to produce acetaldehyde (equation 1). The resulting acetaldehyde can be used as an oxidizing agent. Ni^{2+} is oxidized to Ni^{4+} (equation 2). Complexation reaction is occurred between Ni^{4+} and $S_2O_3^{2-}$ (equation 3). After hydrolysis, the $Ni(S_2O_3)_2$ brings the formation of NiS_2 (equation 4).

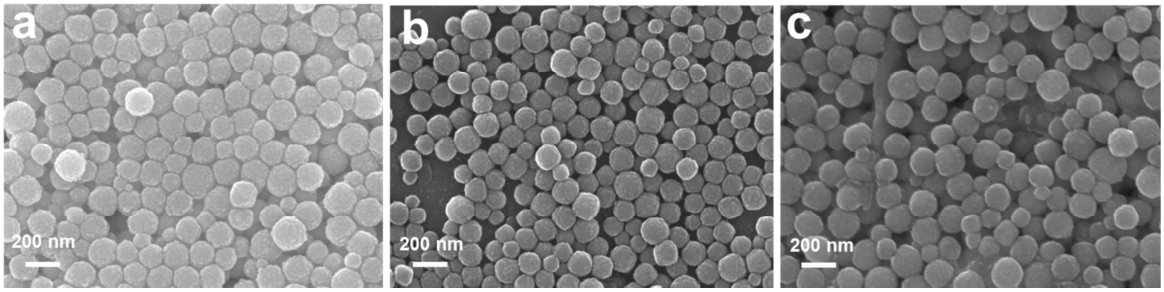

Figure S4. SEM images of the products with different PVP amounts during synthesis. (a) 0.4 g, (b) 0.6 g, (c) 1 g.

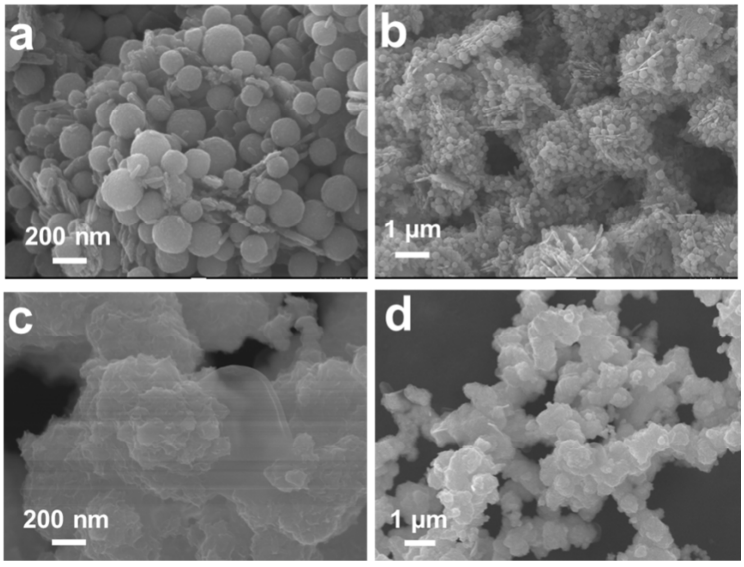

Figure S5. FESEM image of the samples obtained at different solvent. (a) and (b) H_2O. (c) and (d) EG.

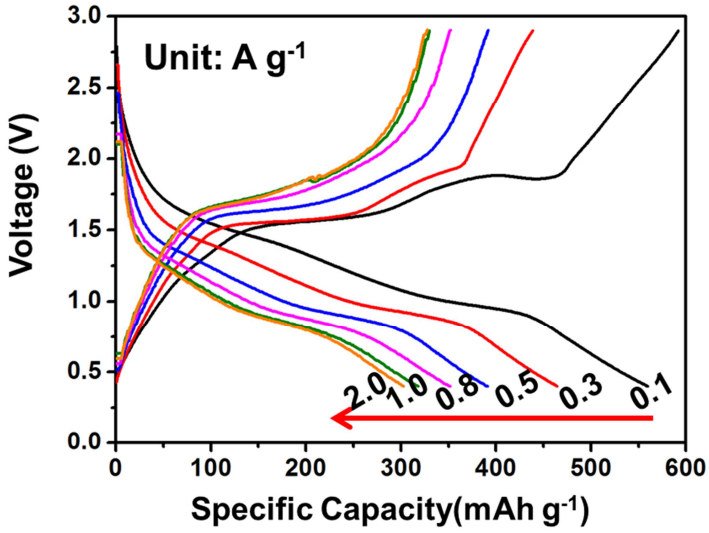

Figure S6. Discharge and charge curves of NiS_2 electrode at different rates.

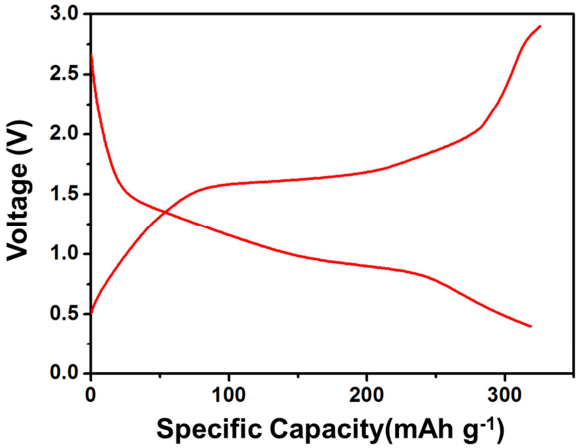

Figure S7. Discharge-charge curves of NiS_2 electrode after 1000 cycles.

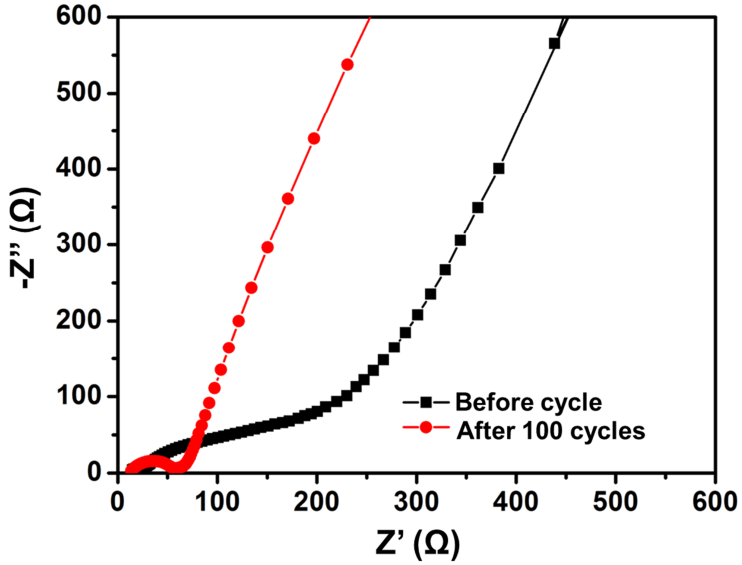

Figure S8. Nyquist plots of mesoporous NiS_2 nanospheres before cycling and after 100 cycles.

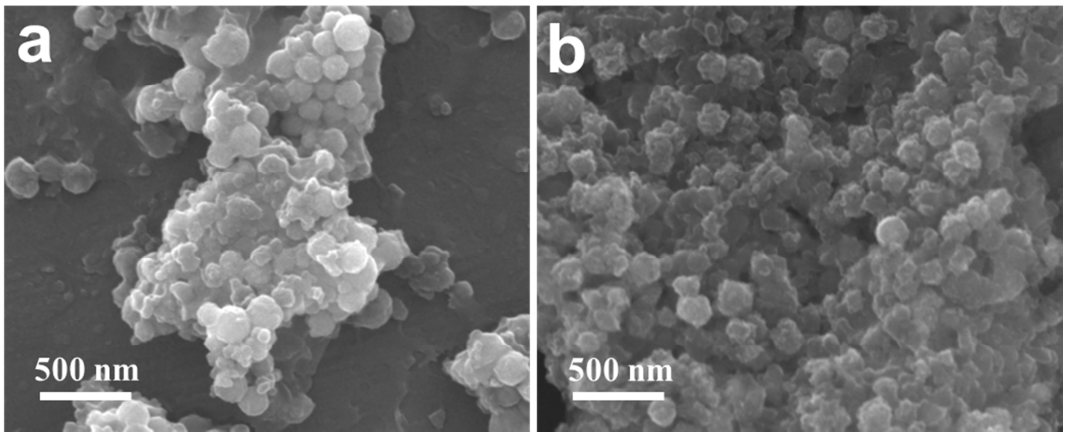

Figure S9. SEM images of mesoporous NiS_2 nanospheres. (a) After 1st cycle, (b) after 200 cycles.

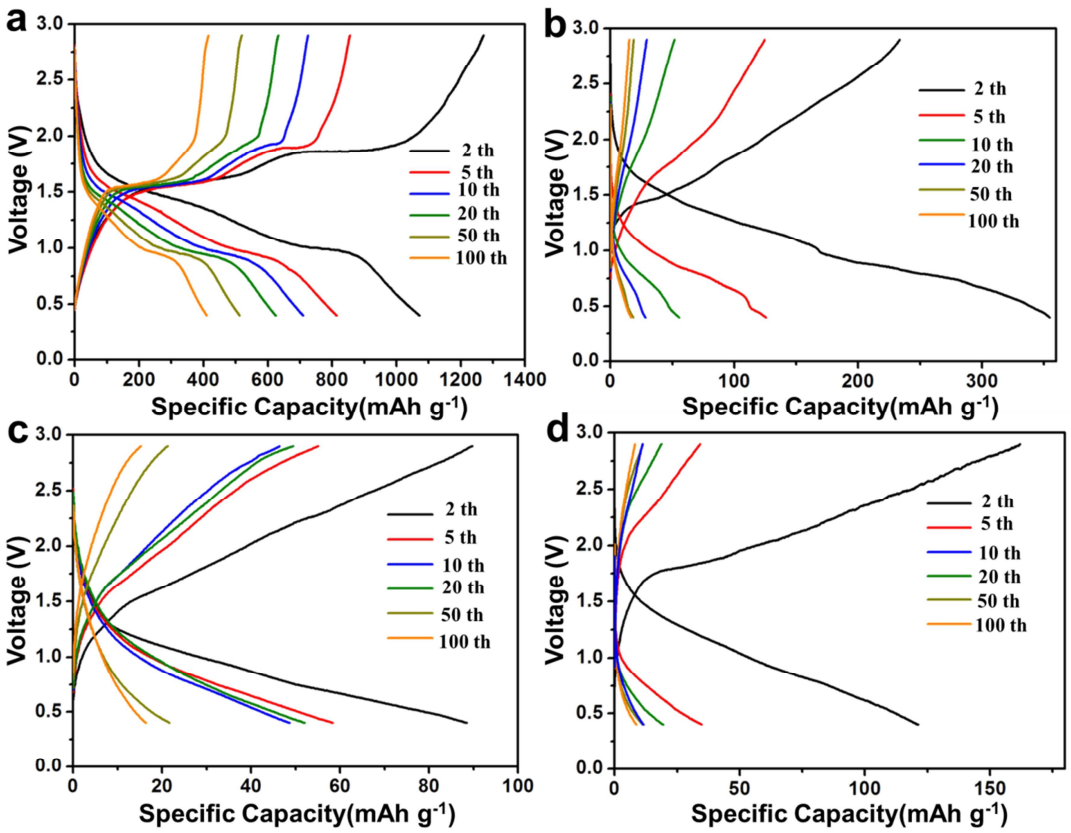

Figure S10. Discharge and charge curves of different electrolytes at 0.1 A g^{-1}. (a) $NaClO_4$/DGM, (b) $NaClO_4$/EC-DMC, (c) $NaPF_6$/PC-EC, (d) $NaClO_4$/PC-DMC.

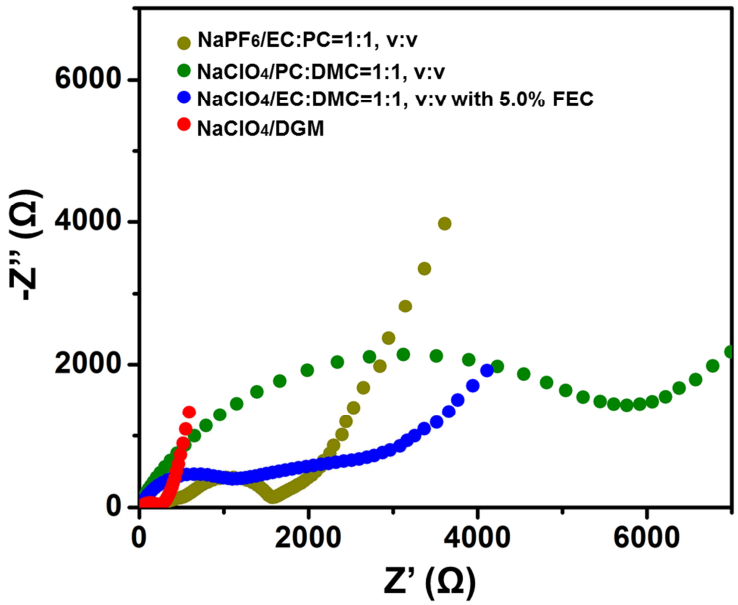

Figure S11. Nyquist plots of mesoporous NiS_2 nanospheres in different electrolytes.

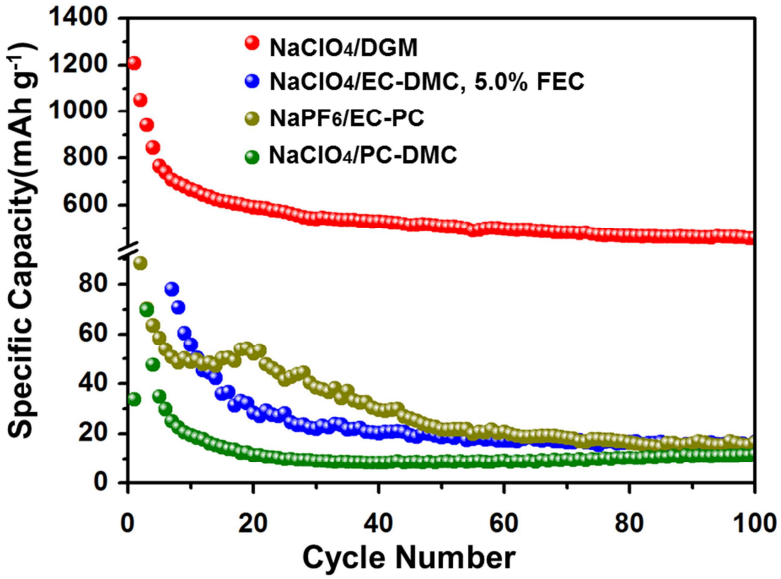

Figure S12. Cycling performance of Na/NiS_2 batteries in different electrolytes at 0.1 A g^{-1}.

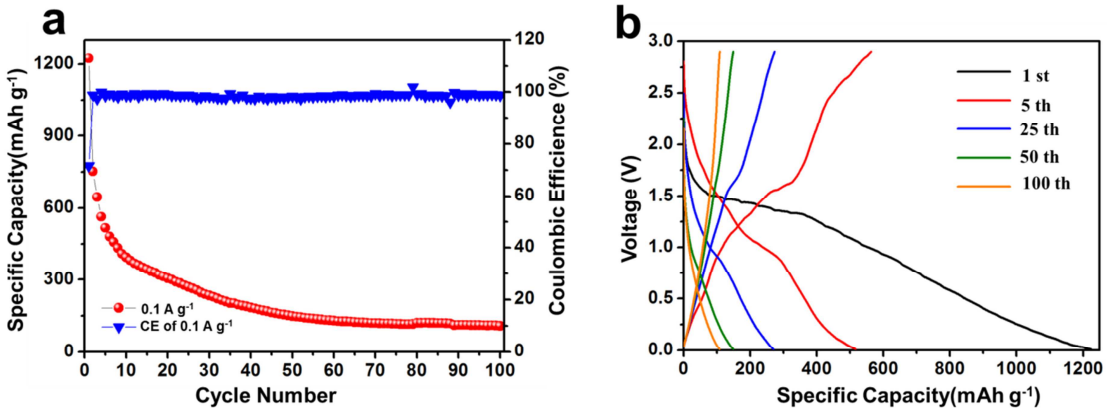

Figure S13. (a) Cycling performance and (b) discharge-charge curves of the mesoporous NiS_2 nanospheres electrode in the voltage range of 0.01−2.9 V at 0.1 A g^{-1}.

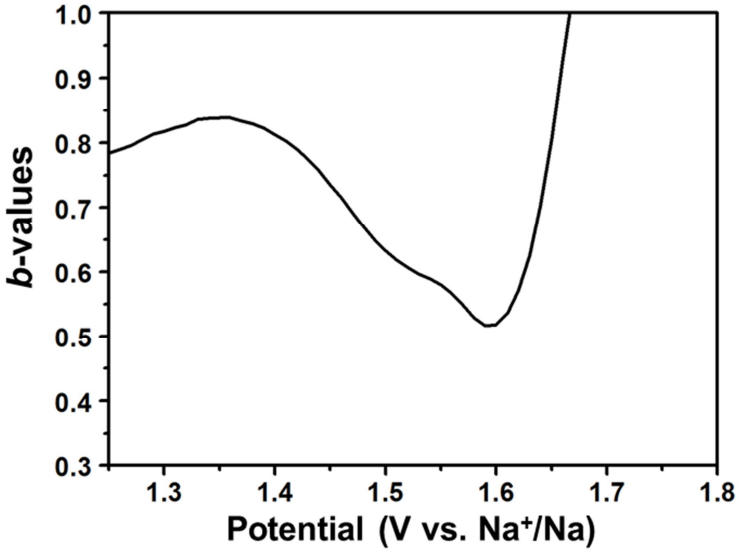

Figure S14. Determination of the anodic *b*-values at different potential during charging.

[1] J. Park , V. Privman, E. Matijević, *J. Phys. Chem. B* **2001**, *105*, 11630.
[2] F. Li, W. Bi, T. Kong, Q. Qin, *Cryst. Res. Technol.* **2009**, *44*, 729.
[3] Z. Quan, C. X. Li, X. Zhang, J. Yang, P. Yang, C. Zhang, J. Lin, *Cryst. Growth Des.* **2008**, *8*, 2384.