Supporting Information

**Ultrahigh-rate nickel monosulfide anodes for sodium/potassium-ion storage**

Milan K. Sadan\textsuperscript{a}, Huihun Kim\textsuperscript{a}, Changhyeon Kim\textsuperscript{a}, Gyu-Bong Cho\textsuperscript{b}, Kwon-Koo Cho\textsuperscript{b}, Jou-Hyeon Ahn\textsuperscript{b}* and Hyo-Jun Ahn\textsuperscript{b}*

\textsuperscript{a}Research Institute for Green Energy Convergence Technology, Gyeongsang National University, Jinju 52828, Republic of Korea

\textsuperscript{b}Department of Materials Engineering and Convergence Technology, RIGET, Gyeongsang National University, Jinju 52828, Republic of Korea

*Corresponding authors

E-mail addresses: ahj@gnu.ac.kr (HJA) and jhahn@gnu.ac.kr (JHA)
**Fig. S1** Field-emission scanning electron microscopy (FESEM) image of nickel monosulfide (NiS) nanoparticles.

**Fig. S2** Cyclic voltammograms of the NiS electrode in a carbonate electrolyte at a scan rate of 0.1 mV s⁻¹ for sodium ion batteries.
**Fig. S3** Voltage profiles of the NiS electrode recorded in a) ether and b) carbonate electrolytes at a current density of 1 A g\(^{-1}\) for sodium ion batteries.

**Fig. S4** Voltage profiles reflecting the rate performances of the NiS electrode in a) ether and b) carbonate electrolytes for sodium ion batteries.
**Fig. S5** a) Voltage profiles and b) corresponding cycling performance and c) rate performance of the NiS electrode with high loading (2.54 g/cm$^2$) in sodium ion batteries.

**Fig. S6** FESEM images of the NiS electrode obtained after cycling in a,c) carbonate and b,d) ether electrolytes for sodium ion batteries.
**Fig. S7** Galvanostatic intermittent titration technique (GITT) profiles of the NiS electrode recorded in a) carbonate and b) ether electrolytes for sodium ion batteries.

**Fig. S8** The contribution ratio of diffusion-controlled and surface-controlled behavior at different scan rates in both a) carbonate and b) ether electrolytes for sodium ion batteries.
Table S1 Comparison of the results obtained in this work with those of the previous studies on NiS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Electrode</th>
<th>Electrolyte</th>
<th>Carbon Content (%)</th>
<th>Currrent collector</th>
<th>First reversible capacity (mAh g⁻¹)</th>
<th>Initial coulombic efficiency (%)</th>
<th>Rate performance (mAh g⁻¹)</th>
<th>Ref</th>
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<tbody>
<tr>
<td>1</td>
<td>NiS plates</td>
<td>1 M NaClO₄ in PC + 5 % FEC</td>
<td>38</td>
<td>Cu</td>
<td>381 (1A g⁻¹)</td>
<td>49</td>
<td>43 (10 A g⁻¹)</td>
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<td>2</td>
<td>NiS spheres</td>
<td>1 M NaClO₄ in PC + 5 % FEC</td>
<td>Not mentioned</td>
<td>Cu</td>
<td>683 (0.1 A g⁻¹)</td>
<td>73</td>
<td>337 (5 A g⁻¹)</td>
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<td>3</td>
<td>CNT@NiS/C</td>
<td>1 M NaClO₄ in EC/DEC</td>
<td>35</td>
<td>Cu</td>
<td>418 (0.1 A g⁻¹)</td>
<td>60</td>
<td>–</td>
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<td>NiS/2D nanosheet</td>
<td>1 M NaClO₄ in EC/PC + 5 % FEC</td>
<td>36</td>
<td>Cu</td>
<td>544 (0.2 A g⁻¹)</td>
<td>77.2</td>
<td>393 (2 A g⁻¹)</td>
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<td>5</td>
<td>Hollow NiS@CNF</td>
<td>1 M NaClO₄ in EC/DEC</td>
<td>25.1</td>
<td>Cu</td>
<td>324.4 (1 A g⁻¹)</td>
<td>71.2</td>
<td>274.7 (5 A g⁻¹)</td>
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<td>Acicular NiS-Ni</td>
<td>1 M NaPF₆ in EC/DEC/DMC + 5 % FEC</td>
<td>Ni</td>
<td>813.6 (0.1 A g⁻¹)</td>
<td>59.2</td>
<td>332.3 (0.4 A g⁻¹)</td>
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<td>NiS/MoS₂/C</td>
<td>1 M NaClO₄ in EC/DMC + 5 % FEC</td>
<td>7.4</td>
<td>Cu</td>
<td>571 (0.1 A g⁻¹)</td>
<td>80.2</td>
<td>398 (5 A g⁻¹)</td>
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<td>NiS/C flower</td>
<td>1 M NaClO₄ in DEGDME</td>
<td>Not mentioned</td>
<td>Cu</td>
<td>776 (0.1 A g⁻¹)</td>
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<td>110 (3 A g⁻¹)</td>
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<td>9</td>
<td>NiS nanoneedles</td>
<td>1 M NaPF₆ in DME</td>
<td>3</td>
<td>Cu</td>
<td>597 (0.1 A g⁻¹)</td>
<td>93</td>
<td>320 (20 A g⁻¹)</td>
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<td>NiS@N doped C</td>
<td>1 M NaClO₄ in EC/DEC + 5% FEC</td>
<td>Not mentioned</td>
<td>Cu</td>
<td>824 (0.1 A g⁻¹)</td>
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<td>688 (3.2 A g⁻¹)</td>
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</table>

**Fig. S9** a) Voltage profiles recorded during cycling at a current density of 25 A g⁻¹. b) FESEM image and c) Nyquist plot of the NiS electrode after 1000 cycles for sodium ion batteries.

**Fig. S10** a) Voltage profile and corresponding cycling performance of NVP cathode at current density of 1.17 A g⁻¹.
Fig. S11  a) Voltage profiles recorded during cycling at 2 A g\textsuperscript{-1}. b) Electrochemical impedance spectrum obtained after cycling the Na\textsubscript{3}V\textsubscript{2}(PO\textsubscript{4}) (NVP)/NiS full-cell.

Fig. S12 FESEM images of the a) NiS anode and b) NVP cathode after cycling.
Fig. S13 Voltage profiles presenting the rate performance of the NiS electrode in a potassium-ion battery.

Fig. S14 a) GITT profiles, b) voltage profiles recorded during cycling at a current rate of 10 A g\(^{-1}\), and c) Nyquist plot obtained after the long-term cycling of the NiS electrode in a potassium-ion battery.

References


