

Fig.S1 XRD patterns of pristine $NiCo_2S_4$ product



Fig.S2 FESEM images of pristine $NiCo_2S_4$ nanostructures.



Fig.S3 The electrochemical performance of pristine NiCo₂S₄ electrode, (a) CV curves of pristine NiCo₂S₄ electrode collected at scan rates from 5~50 mV s⁻¹ (b) Galvanostatic charge and discharge curves collected at current densities from 2 to 20 mA cm⁻²



Fig.S4 The electrochemical performance of 0.25 Mn-NiCo₂S₄ electrode (a) CV curves of 0.25 Mn-NiCo₂S₄ electrode collected at scan rates from 5~50 mV s⁻¹ (b) Galvanostatic charge and discharge curves collected at current densities from 2 to 20 mA cm⁻²



Fig.S5 The electorchemical performance of 1 Mn-NiCo₂S₄ electrode (a) CV curves of 1 Mn-NiCo₂S₄ electrode collected at scan rates from 5~50 mV s⁻¹ (b) Galvanostatic charge and discharge curves collected at current densities from 2 to

mА

20



Fig.S6 (a) CV curves of NiCo₂S₄ // AC device collected at scan rates from 5~100 mV s⁻¹ (b) Galvanostatic charge and discharge curves of NiCo₂S₄ // AC device collected at current densities from 2 to 20 mA cm⁻²