Electronic Supplementary Material (ESI) for Dalton Transactions.

Electronic Supplementary Information

MOF-derived hierarchical core-shell hollow Co_3S_4@$NiCo_2O_4$ nanosheet arrays for asymmetric supercapacitors

Ye Tian,‡[a] Zhigao Xue,‡[a] Qingqing Zhao,[a] Jie Guo,*[a] Kai Tao*[a] and Lei Han[a]

[a]School of Materials Science & Chemical Engineering, Ningbo University, Ningbo, Zhejiang 315211, China.

Email: taokai@nbu.edu.cn; guojie@nbu.edu.cn.

Electrochemical calculation

The specific capacitance (C_s, F/cm^2) of the electrode material is calculated by following equation:

$$C_s = \frac{I \times \Delta t}{S \times \Delta V} \quad (1)$$

where I (A), Δt (s), ΔV (V) and S (cm^2) are the discharging current, discharging time, voltage window for charge-discharge process and area of active materials, respectively.

The specific capacitance (C_s, F/g) of the electrode material is calculated by following equation:

$$C_s = \frac{I \times \Delta t}{m \times \Delta V} \quad (2)$$

where I (A), Δt (s), ΔV (V) and m (g) are the discharging current, discharging time, voltage window for charge-discharge process and mass of active materials, respectively.

The charge storage mechanism and reaction kinetics ware analysed by the formula as follows:

$$i = av^b \quad (3)$$

where I (A), v (mV s^{-1}), a value and b value are peak curren, scan rate, constant and constant, respectively. When b = 0.5, the material storage mechanism is considered as battery type. When b=1, the material storage mechanism is considered as capacitive character.

The capacitive ($k_1 v$) and diffusion-controlled ($k_2 v^{1/2}$) currents are separated by following equation:

$$i = k_1 v + k_2 v^{1/2} \quad (4)$$

In the two-electrode test, the positive and negative charges should be balanced, so the mass of positive and negative active substances is as follows:

$$Q_- = m_- \times C_- \times \Delta V_- = m_+ \times C_+ \times \Delta V_+ = Q_+ \quad (5)$$

Where m (g), C (F/g) and ΔV (V) are active materials, specific capacitance, and charge-discharge voltage of positive and negative electrodes, respectively.

The energy density (E, Wh/kg) and power density (W/kg) calculation equation of Co_3S_4@$NiCo_2O_4$/rGO/NF//AC/NF cell is as follows:

$$E = \frac{C_s \times (\Delta V)^2}{2 \times 3.6} \quad (6)$$

$$P = \frac{3600 \times E}{\Delta t} \quad (7)$$

Where C (F/g), Δt (s) and ΔV (V) are specific capacitance, discharging time and working voltage of Co_3S_4@$NiCo_2O_4$/rGO/NF//AC/NF cell, respectively.

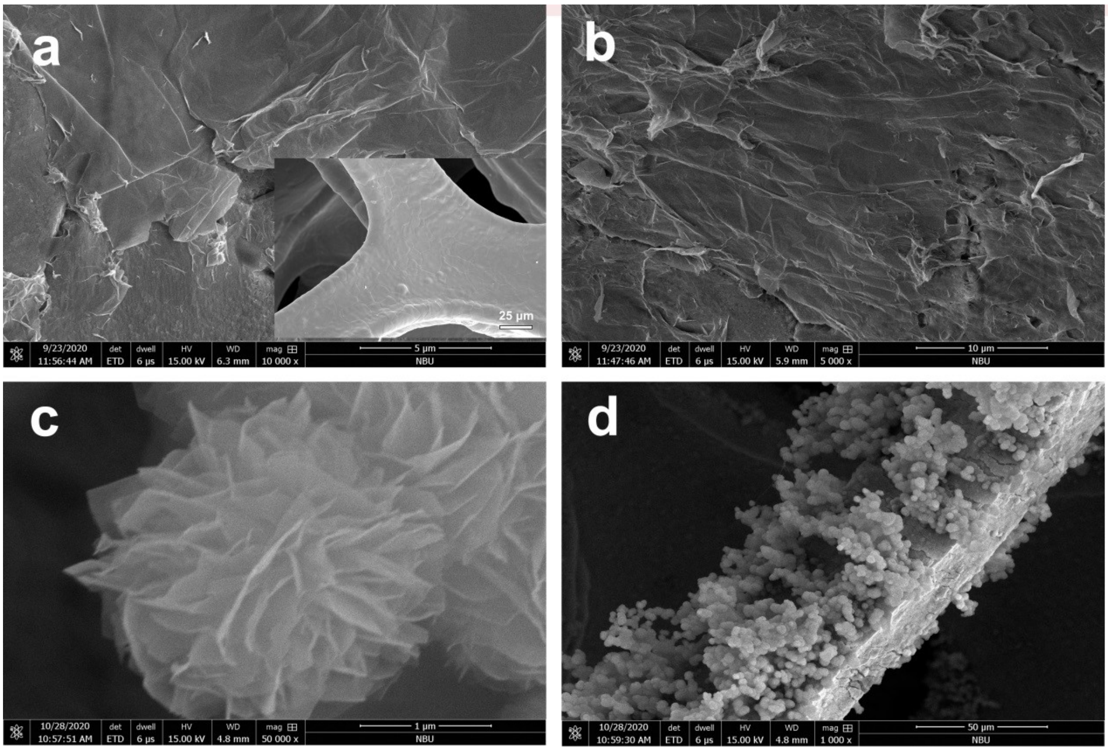

Fig. S1 SEM images of sample. (a,b) rGO/NF, inset: bare NF; (c,d) $NiCo_2O_4$/rGO/NF.

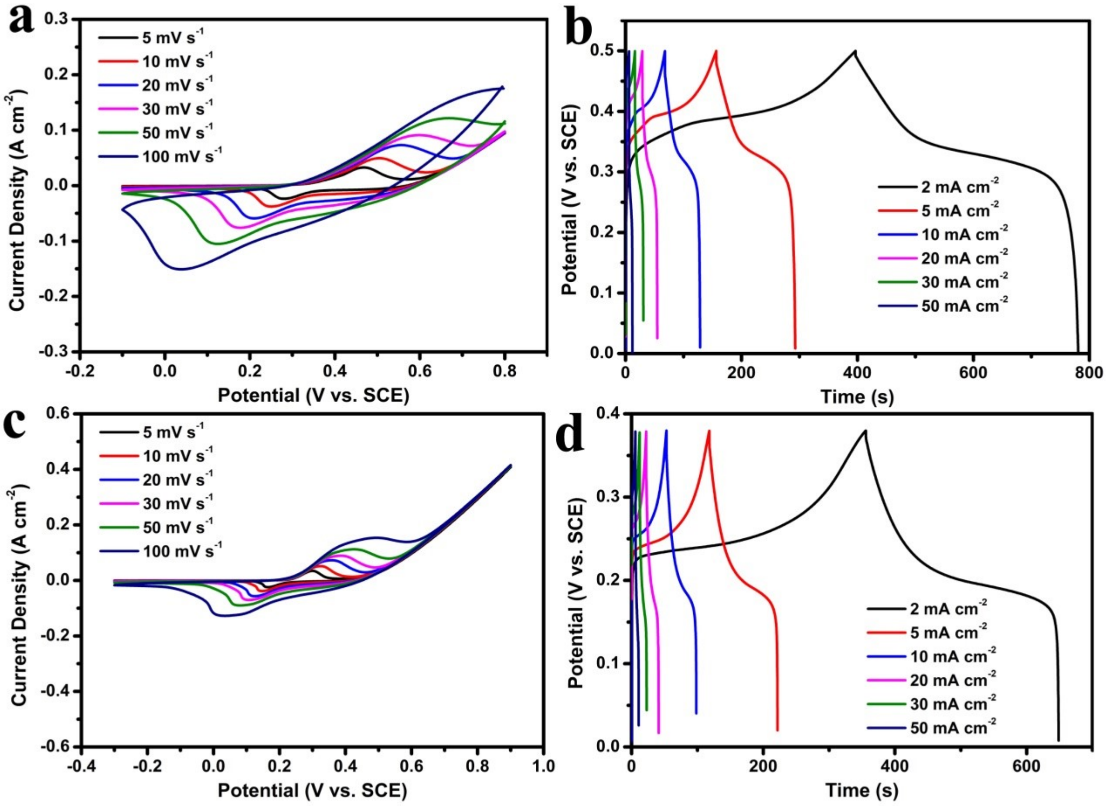

Fig. S2 (a) CV curves of the Co_3S_4/rGO/NF at different scanning rates. (b) GCD curves of the Co_3S_4/rGO/NF at different current densities. (c) CV curves of the $NiCo_2O_4$/rGO/NF at different scanning rates. (d) GCD curves of the $NiCo_2O_4$/rGO/NF at different current densities.

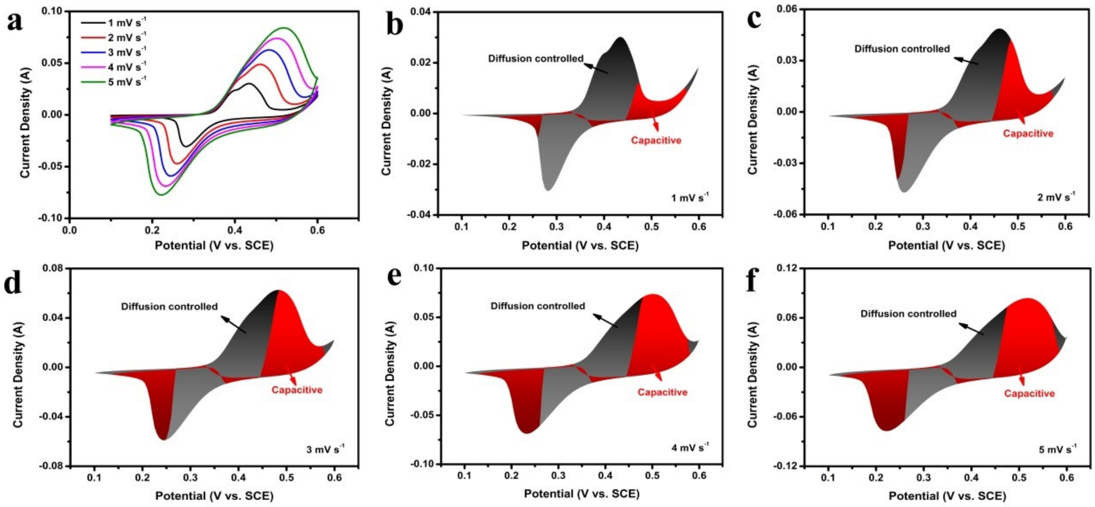

Fig. S3 (a) CV curves of the Co_3S_4@$NiCo_2O_4$/rGO/NF at different scanning rates. CV curves with capacitive fraction shown by the shaded area at a scan rate at (b) 1 mV s^{-1}, (c) 2 mV s^{-1}, (d) 3 mV s^{-1}, (e) 4 mV s^{-1} and (f) 5 mV s^{-1}.

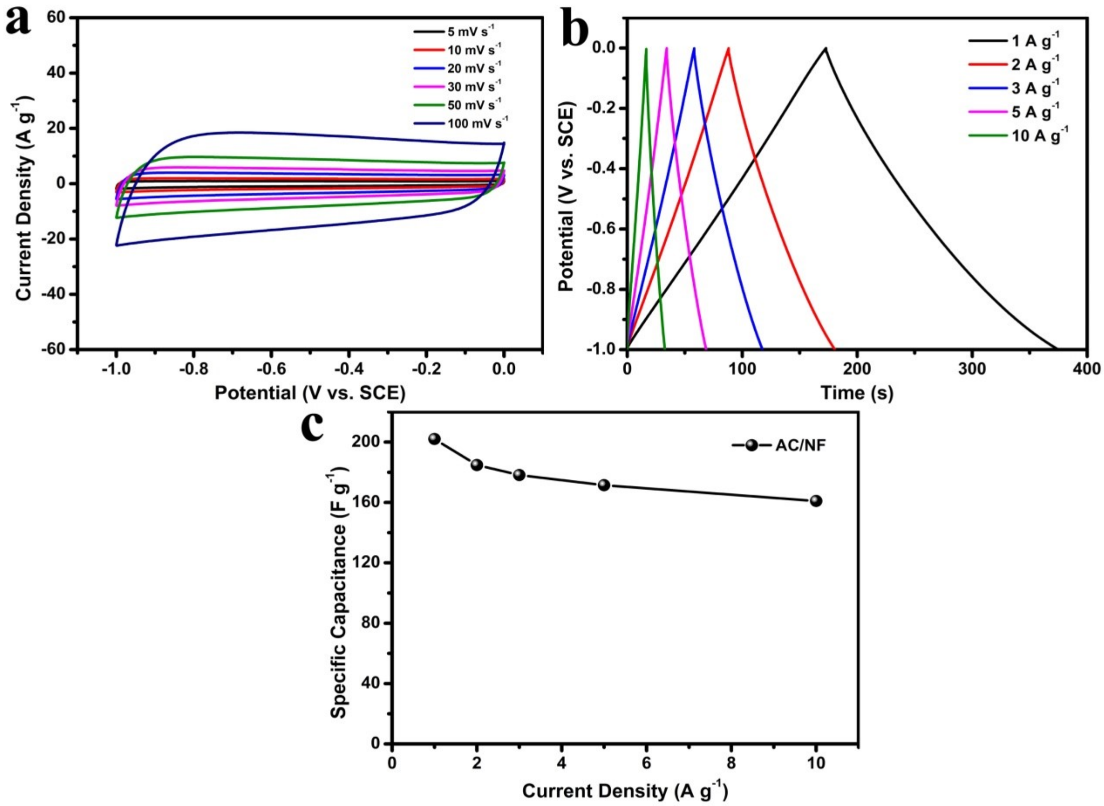

Fig. S4 (a) CV curves of the AC at different scanning rates. (b) GCD curves of the AC at different current densities. (c) Specific capacitances of the AC at different current densities.