Electronic Supplementary Information (ESI)

Hybrid Structure of Cobalt Monoxide Nanowire @ Nickel Hydroxidenitrate Nanoflake Aligned on Nickel Foam for High-Rate Supercapacitor

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Ⅰ. CV and charge-discharge testing of the nickel foam

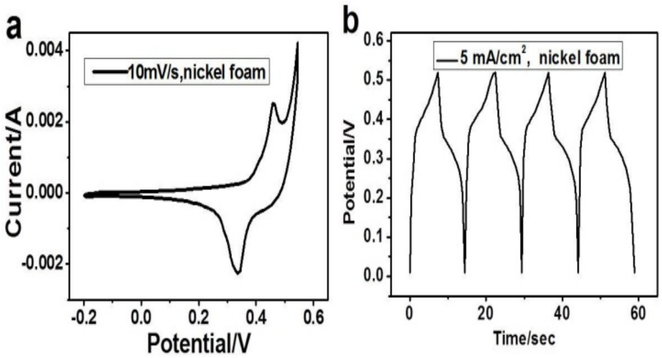

Fig. S1. A nickel foam (330 g/m^2) was tested independently (a) at a scan rate of 10 mV/s in a CV testing; (b) at a charge-discharge rate of 5 mA/cm^2.

Calculation:

As both nickel foam substrate and active materials contribute to the charge-discharge behavior of the electrode[1], and they are under the same current, charge-discharge time and potential window, formula (1): $C = It/ m\Delta V$ can be converted to[2]:

$$It/\Delta V = C_s*m_s + C_a*m_a,$$

where C_s, m_s is the capacitance and the mass of the nickel foam substrate, C_a, m_a is the capacitance and the mass of the active materials.

For a typical charge-discharge process of the hybrid structure on nickel foam (for example, current density is 5 mA/cm^2), the contribution of 1 cm^2 nickel foam can be calculated independently from the above curve in Fig. S1b with formula (1),

$$C_s*m_s = It/\Delta V = (5\ mA/cm^2*1cm^2) * 6.72s/0.51V$$
$$= \sim 66\ mF$$

And according to Fig. 4c, under the same current density, the contribution of the hybrid structure on 1 cm^2 nickel foam is,

$$C_a*m_a = It'/\Delta V - C_s*m_s$$
$$= (5\ mA/cm^2*1cm^2) * 251s/0.51V - 66\ mF$$
$$= 2395mF,$$
$$(C_s*m_s) / (C_a*m_a) = 66mF/2395mF = 2.89\%$$

Thus the **contribution of nickel foam in this case is 2.89% of the total capacity of the hybrid structure**.

Ⅱ. NiHON powder sample testing and specific capacitance calculation

For nickel hydroxidenitrate powder synthesis, 0.25 M $Ni(NO_3)_2$ ethanol solution was first prepared, and then transferred to a Teflon-lined stainless steel autoclave to react at 130 ^{o}C for 3 h. After cooling down to room temperature, the green precipitation was washed with deionized water and dried at 60 ^{o}C to obtain the final sample.

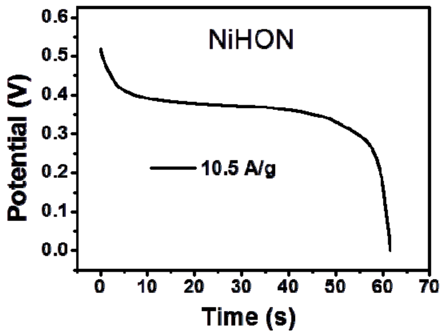

Fig. S2. Powder sample of NiHON has been tested and showed a capacitance of ~1200 F/g at 10.5 A/g.

If we could simply add CoO (307 F/g at 4.55 A/g) and NiHON with the same mass ratio to that in the hybrid structure (CoO: ~2.2 mg, NiHON: ~0.8 mg), the capacitance of the mixture (C) would be calculated as,

$$C*m = It/\Delta V = C_c*m_c + C_n*m_n,$$

where $m=m_c+m_n$ (m, m_c and m_n is the mass of the mixture, CoO and NiHON, respectively),and C_c, C_n is the capacitance of CoO and NiHON, respectively.

At the current density of 13.33 A/g, even if CoO and NiHON could maintain a same capacitance (as that at lower current density) of 307 F/g and 1200 F/g, then from the above formula,

$$C*3mg=307F/g*2.2mg+1200F/g*0.8mg$$

$$C=\sim 545\ F/g.$$

The result is still poorer than the data we get from the hybrid structure, which shows a capacitance of 671.3 F/g at the current density of 13.33 A/g.

References:

1. W. Xing, S. Z. Qiao, X. Z. Wu, X. L. Gao, J. Zhou, S. P. Zhuo, S. B. Hartono, D. H. Jurcakova, J. Power Sources., 2011.196(8), 4123.
2. X. Y. Lang, A. Hirata, T. Fujita and M. W. Chen, *Nat. Nanotechnol.,*2011， 6, 232.