Supporting Information

Design of $NiCo_2O_4$ @ $NiMoO_4$ core-shell nanoarrays on nickel foam to explore the application in both energy storage and electrocatalysis

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Before synthesizing, Ni foam substrates (2 cm × 2 cm × 1.6 mm, 110 PPI pore size, 320 g m^{-2}) were cleaned in an ultrasonic bath with 3 M HCl solution for 20 min to get rid of the NiO layer and impurities adsorbed on the surface, followed by rinsing with deionized water (DIW) until the *p*H~7, and then absolute ethanol, acetone and absolute ethanol in sequence, 10 min each, and dried in a vacuum oven overnight at 60 ℃.

For supercapacitors, it was well-known that the charge balance between the two electrodes will follow the relationship $q^+ = q^-$, where the charge stored by each electrode usually depends on the specific capacitance (C), the potential window (ΔV) and the mass of active material (m), as is shown in the eqn (1):

$$q = C \times \Delta V \times m \quad (1)$$

The mass ratio between the two electrodes could be calculated by the formula:

$$m^+/m^- = C^-\Delta V^-/C^+\Delta V^+ \quad (2)$$

wherein m^+ (g), C^+ (F g^{-1}), ΔV^+ (V) was the mass, specific capacity, potential window of the positive materials; m^- (g), C^- (F g^{-1}), ΔV^- (V) was the mass, specific capacity, potential window of the negative materials. In our electrochemistry measurement of the BSH devices, the m^+/m^- was about 1:3.

Tab. S1 Electrochemical performances of all the prepared electrodes.

Sample name	Discharging time (s)	M (mg)	C_s (C g^{-1})	Cycling	R_s (Ω)
NC-NW	83.2	0.98	848.98	50.12%/5000	1.44 Ω
NCNMW-1	93.7	1.05	892.38	66.08%/5000	1.39 Ω
NCNMW-2	122.6	1.13	1084.96	87.18%/5000	1.22 Ω
NCNMW-3	112.9	1.21	933.06	82.85%/5000	1.24 Ω
NC-NS	102.1	1.12	911.61	72.06%/5000	1.28 Ω
NCNMS-1	188.2	1.51	1246.36	87.89%/5000	1.15 Ω
NCNMS-2	261.7	1.58	1656.33	102.78%/5000	0.82 Ω
NCNMS-3	233.1	1.77	1260.45	88.17%/5000	0.92 Ω

Tab. S2 Electrochemical performance of NCNMW-2 electrodes.

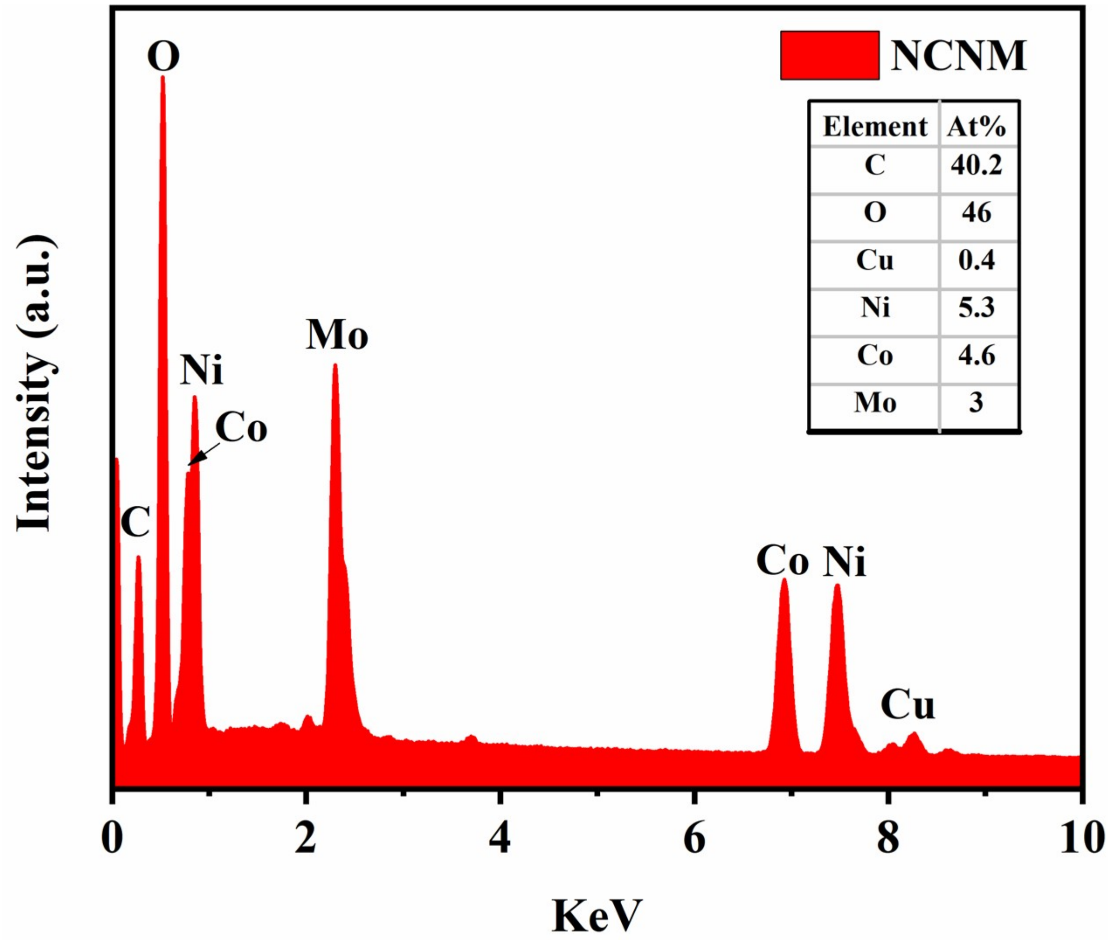
Current density	3 mA cm^{-2}	5 mA cm^{-2}	8 mA cm^{-2}	10 mA cm^{-2}	20 mA cm^{-2}	40 mA cm^{-2}
C_s (C g^{-1})	1292.65	1184.07	1108.67	1084.96	946.90	828.32

Tab. S3 Capacitive contribution of NCNMW-2 electrode.

Scan rate	5 mV s^{-1}	10 mV s^{-1}	15 mV s^{-1}	20 mV s^{-1}	25 mV s^{-1}	30 mV s^{-1}	35 mV s^{-1}	40 mV s^{-1}
Capacitive contribution	12 %	16 %	17 %	19 %	21 %	23 %	26 %	28 %

Tab. S4 Electrochemical performances of assembled BSH devices.

names / C (F g^{-1}) / current density	NCNMS-2//AC	NCNMW-2//AC
3 mA cm^{-2}	85.99	74.55
5 mA cm^{-2}	81.16	71.15
10 mA cm^{-2}	80.28	65.47
20 mA cm^{-2}	68.31	59.03
30 mA cm^{-2}	68.13	53.92
40 mA cm^{-2}	64.79	50.79
50 mA cm^{-2}	64.26	46.17



Element	At%
C	40.2
O	46
Cu	0.4
Ni	5.3
Co	4.6
Mo	3

Fig. S1 EDS results for NCNM composites.

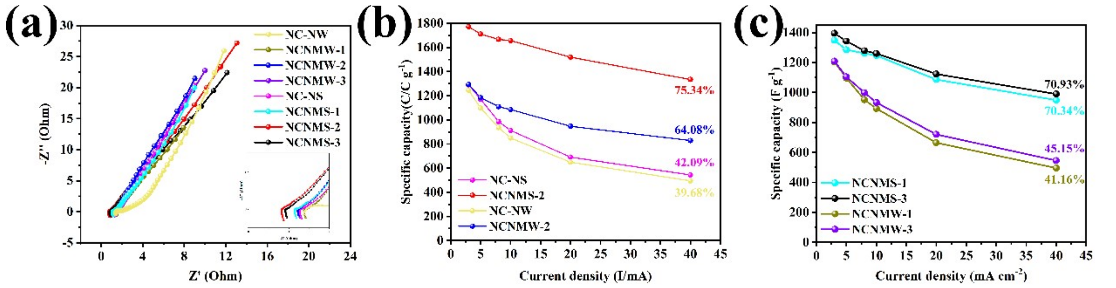


Fig. S2 EIS curves of (a) NC-NW, NCNMW-1, NCNMW-2, NCNMW-3, NC-NS, NCNMS-1, NCNMS-2 and NCNMS-3 electrodes. (b) Specific capacity vs. current density of NC-NW, NC-NS, NCNMW-2 and NCNMS-2; (c) Specific capacity vs. current density of NCNMW-1, NCNMW-3, NCNMS-1 and NCNMS-3.

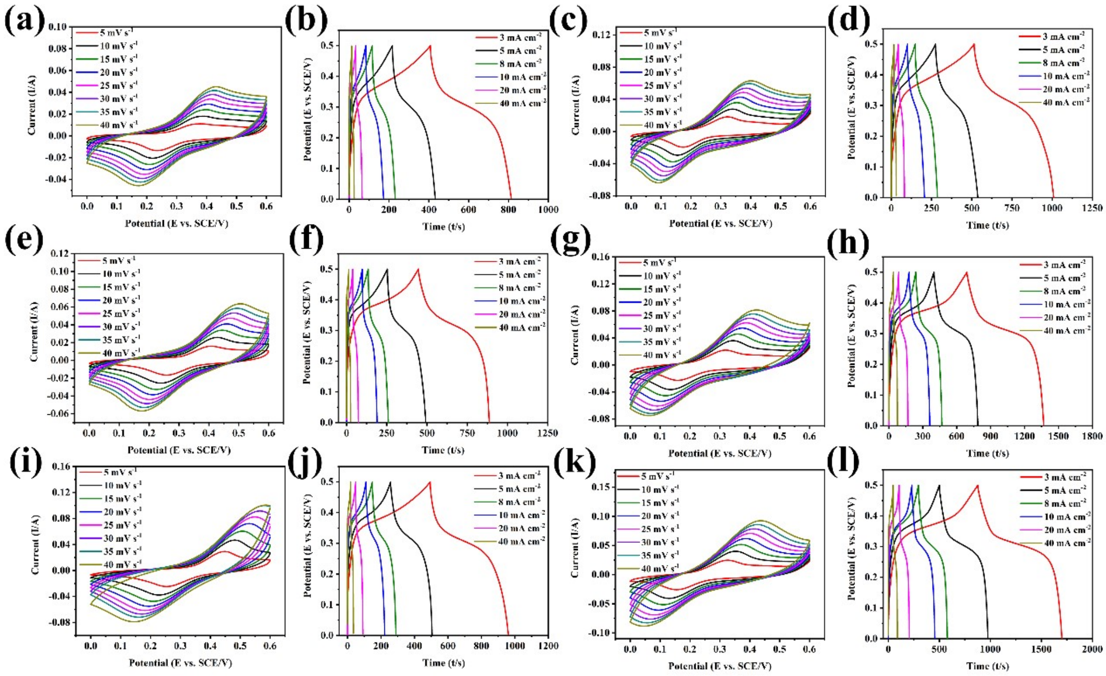


Fig. S3 CV curves of (a) NC-NW, (c) NC-NS, (e) NCNMW-1, (g) NCNMS-1, (i) NCNMW-3, (k) NCNMS-3 electrode at various scan rates ranging from 5 to 40 mV s^{-1}; GCD curves of (b) NC-NW, (d) NC-NS, (f) NCNMW-1, (h) NCNMS-1, (j) NCNMW-3, (l) NCNMS-3 electrode at different current densities.

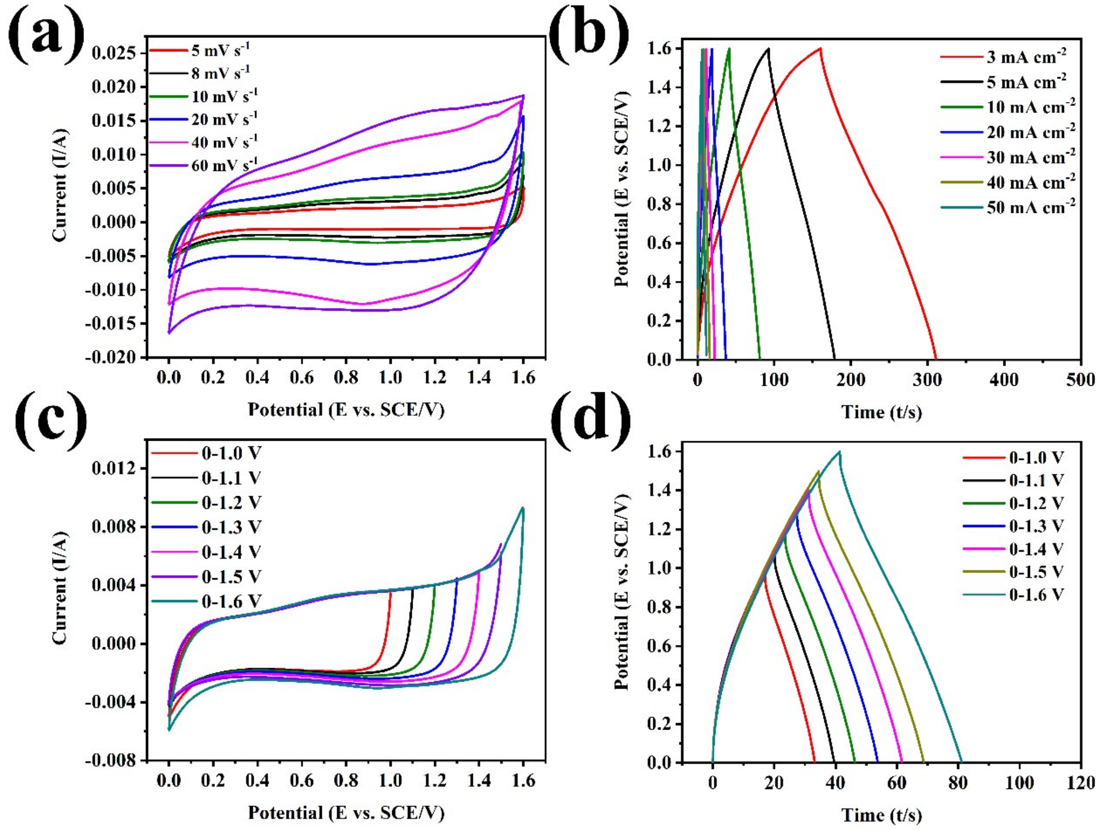


Fig. S4 (a) CV curves at different scan rates of NCNMW-2//AC BSH device; (b) GCD curves at various current densities; (c) CV curves of the NCNMW-2//AC BSH device collected at different potential windows at a scan rate of 10 mV s^{-1}; (d) GCD curves of NCNMW-2//AC BSH device at a current density of 10 mA cm^{-2} with various potential windows.

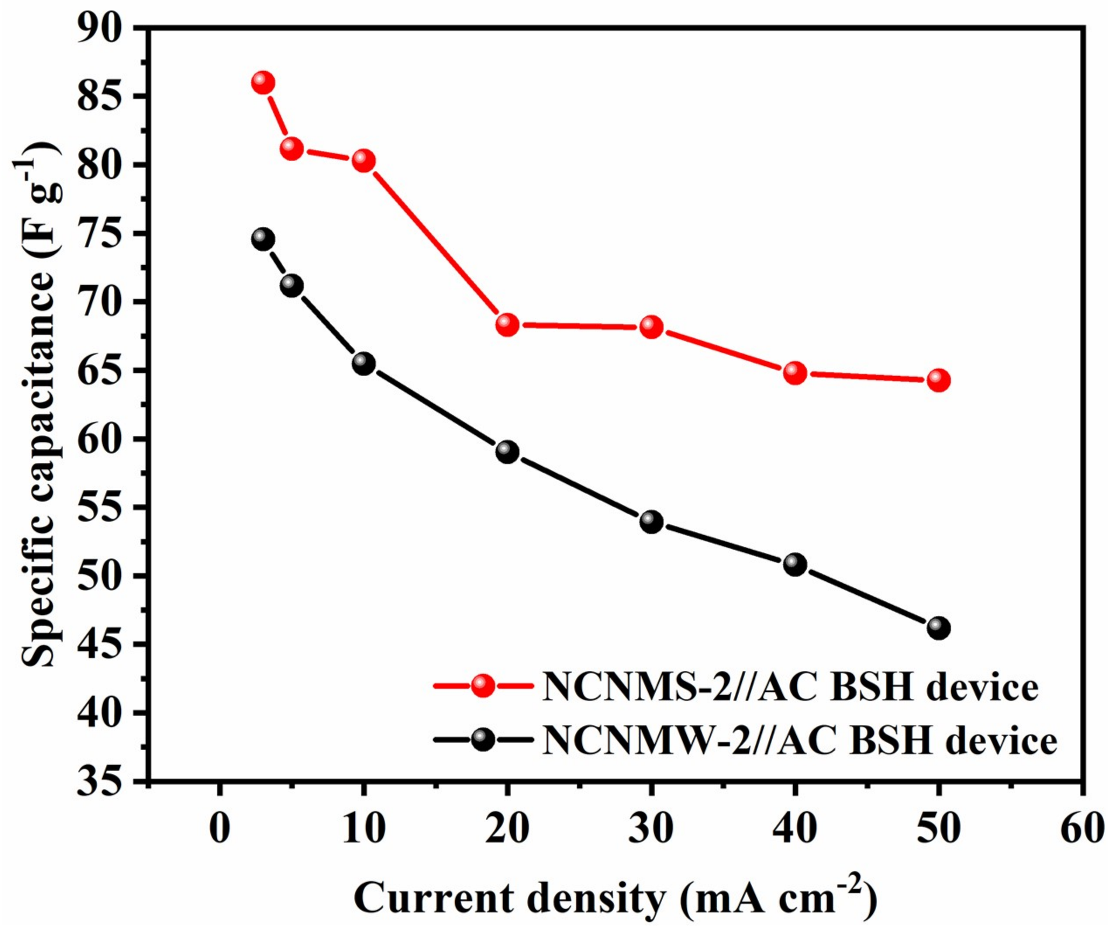


Fig. S5 Specific capacitance vs. current density curves of NCNMS-2//AC and NCNMW-2//AC BSH devices.