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$MnCo_2S_4$/$FeCo_2S_4$ "lollipop" arrays on hollow N-doped carbon skeleton as flexible electrodes for hybrid supercapacitors

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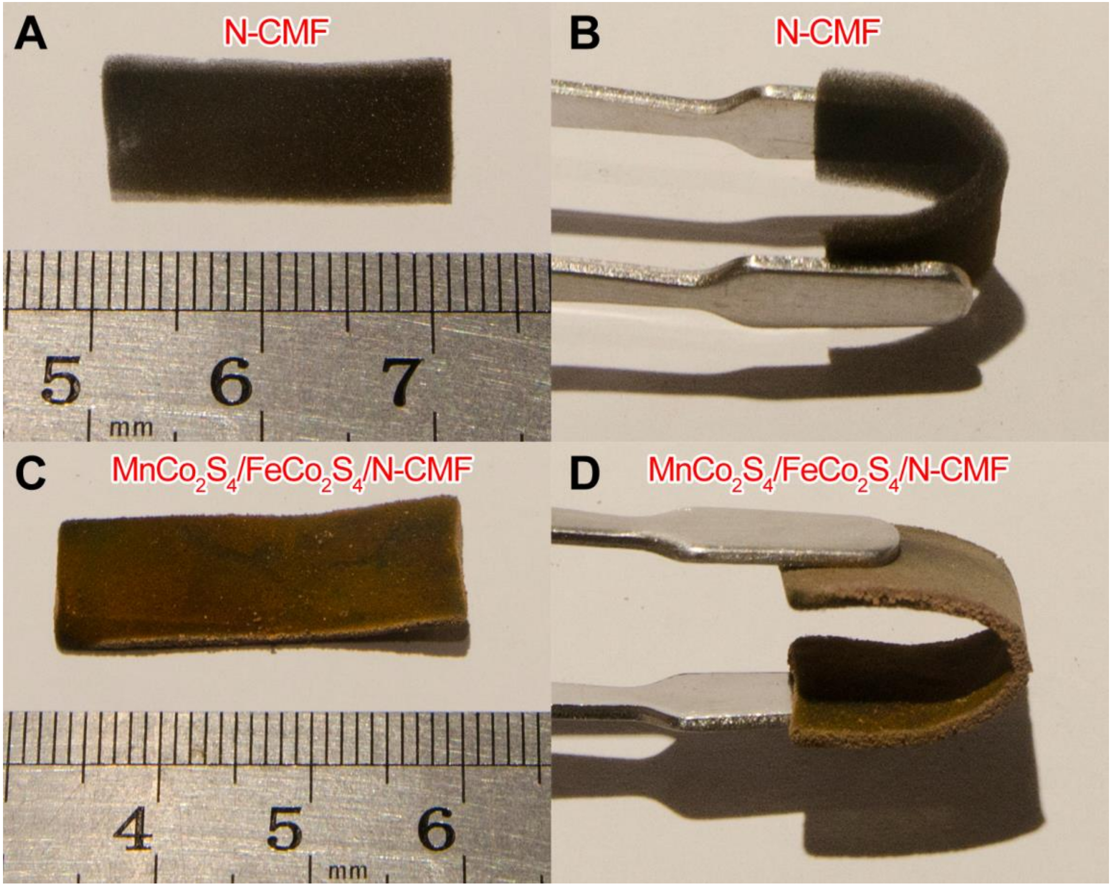

Figure S1. Digital photographs of self-supported and flexible (A, B) N-CMF and (C, D) $MnCo_2S_4/FeCo_2S_4$/N-CMF composite.

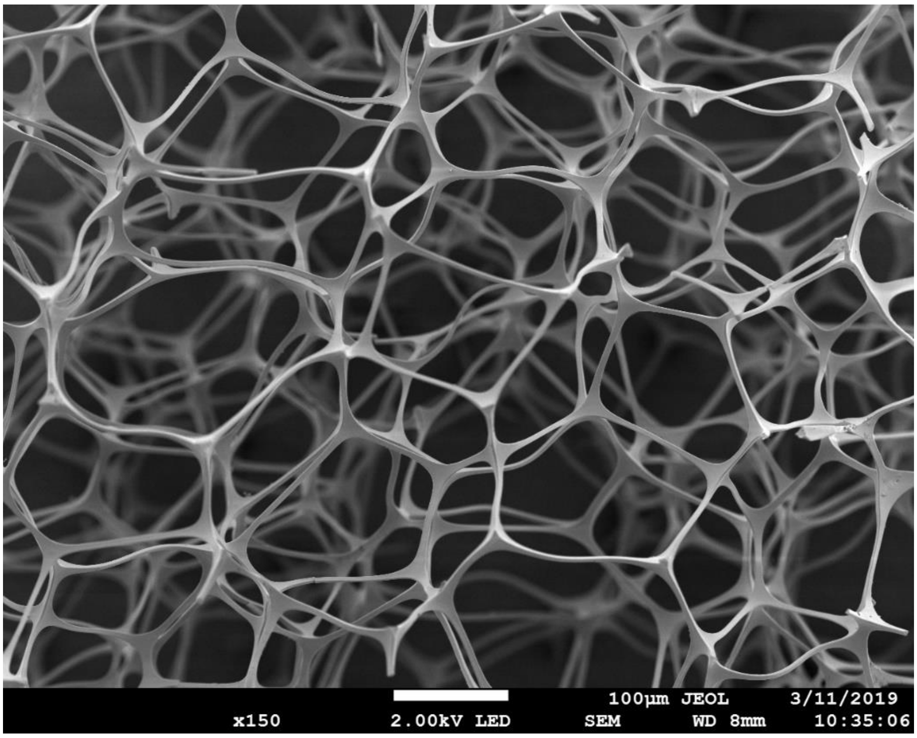

Figure S2. SEM image of melamine formaldehyde (MF) resin foam.

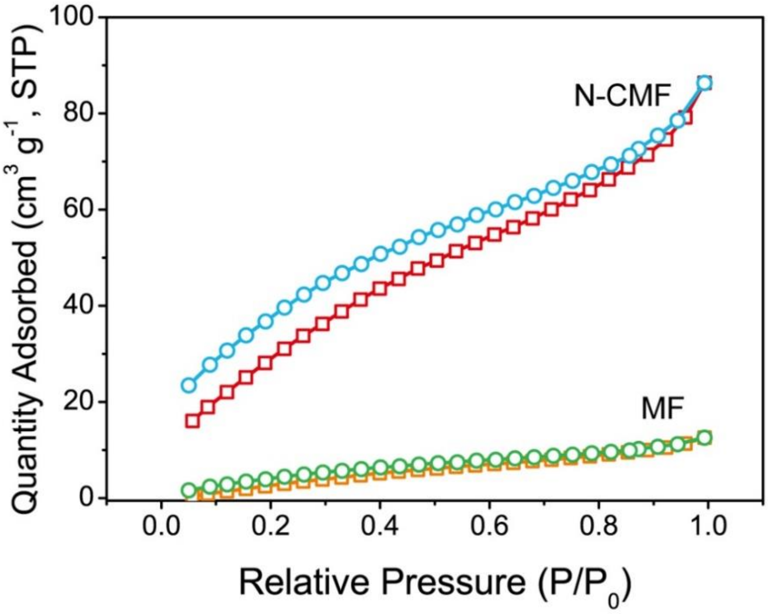

Figure S3. Nitrogen adsorption-desorption isotherms of MF foam and N-CMF.

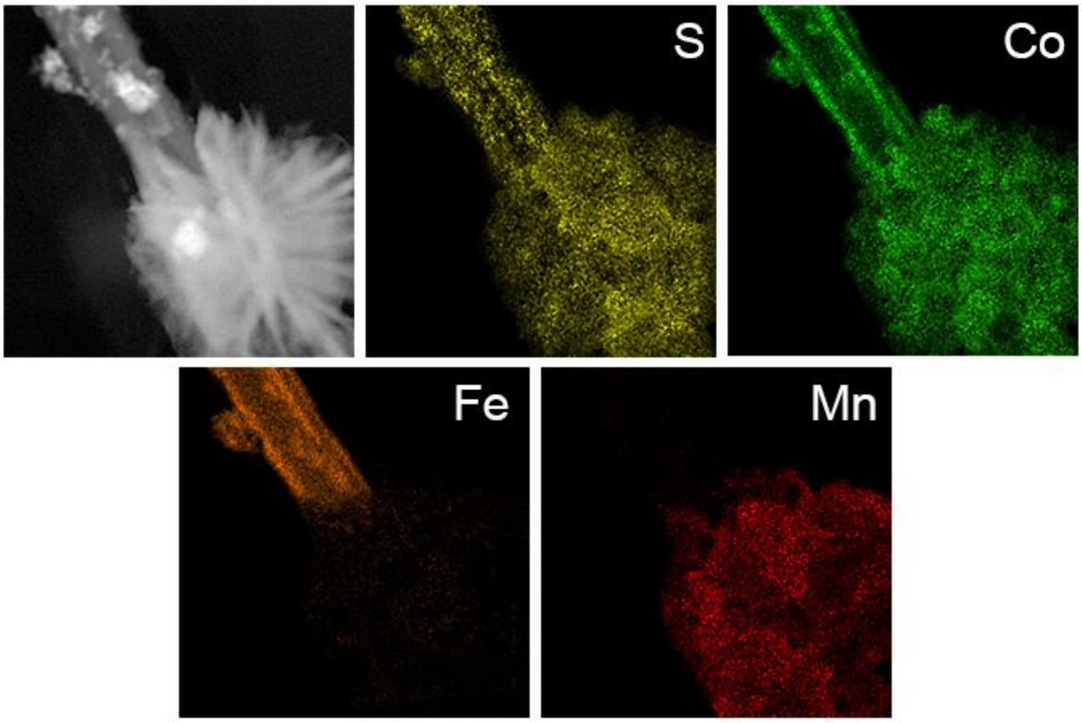

Figure S4. STEM-EDS mapping of $MnCo_2S_4/FeCo_2S_4$ heterostructure.

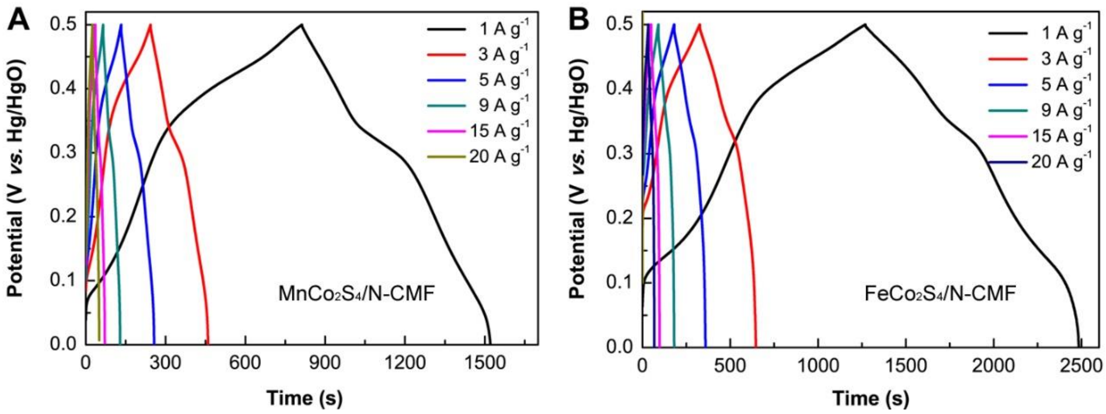

Figure S5. GCD curves of $MnCo_2S_4$/N-CMF and $FeCo_2S_4$/N-CMF at various current densities.

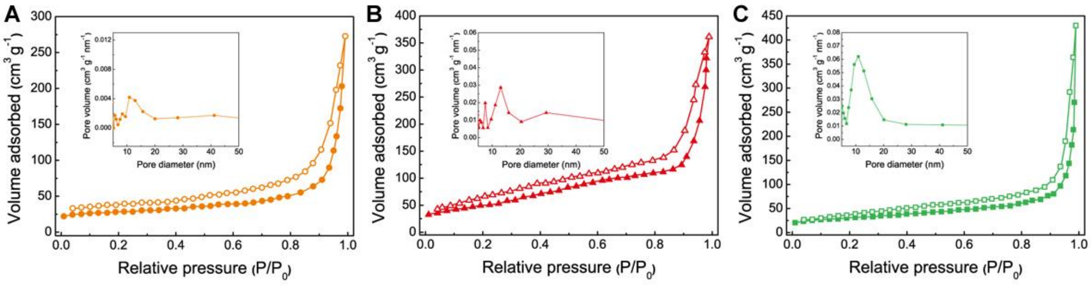

Figure S6. Nitrogen adsorption-desorption isotherms of (A) $MnCo_2S_4$/N-CMF, (B) $FeCo_2S_4$/N-CMF and (C) $MnCo_2S_4$/$FeCo_2S_4$/N-CMF. The inset are their corresponding pore size distribution.

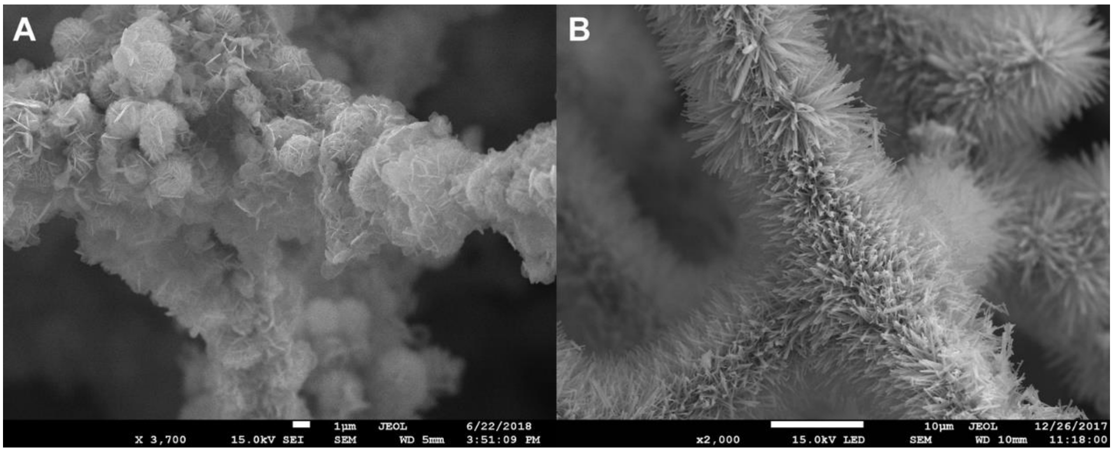

Figure S7. SEM images of $MnCo_2S_4$/N-CMF and $FeCo_2S_4$/N-CMF composite foam.

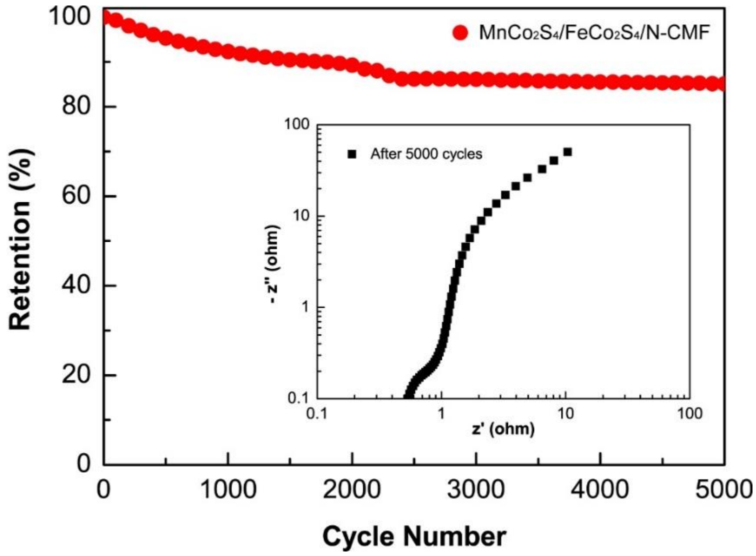

Figure S8. Cycling test of $MnCo_2S_4/FeCo_2S_4$/N-CMF electrode over 5000 charge/discharge cycles at a current density of 5 A g^{-1}.

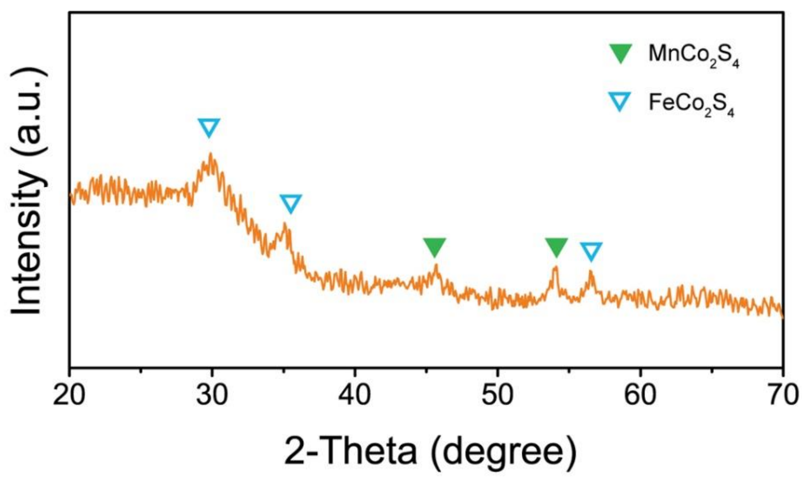

Figure S9. XRD pattern of $MnCo_2S_4/FeCo_2S_4$/N-CMF electrode after cycling test.

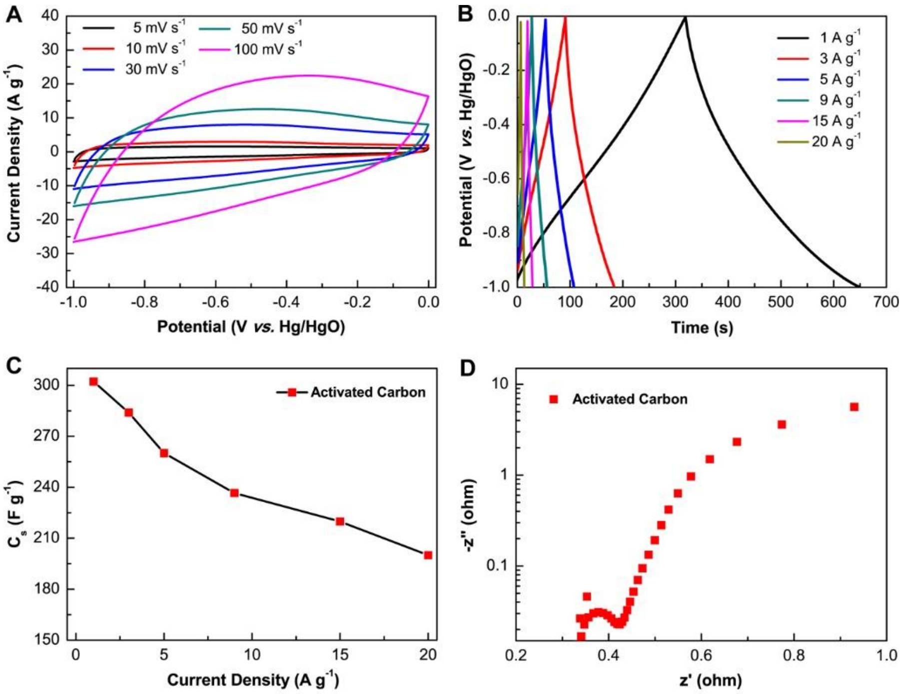

Figure S10. (A, B) CV curves and GCD curves of AC electrode at various scan rates and current densities. (C) Specific capacitance of AC electrode at different current densities. (D) Nyquist plots of AC electrode recorded at open-circuit potential.

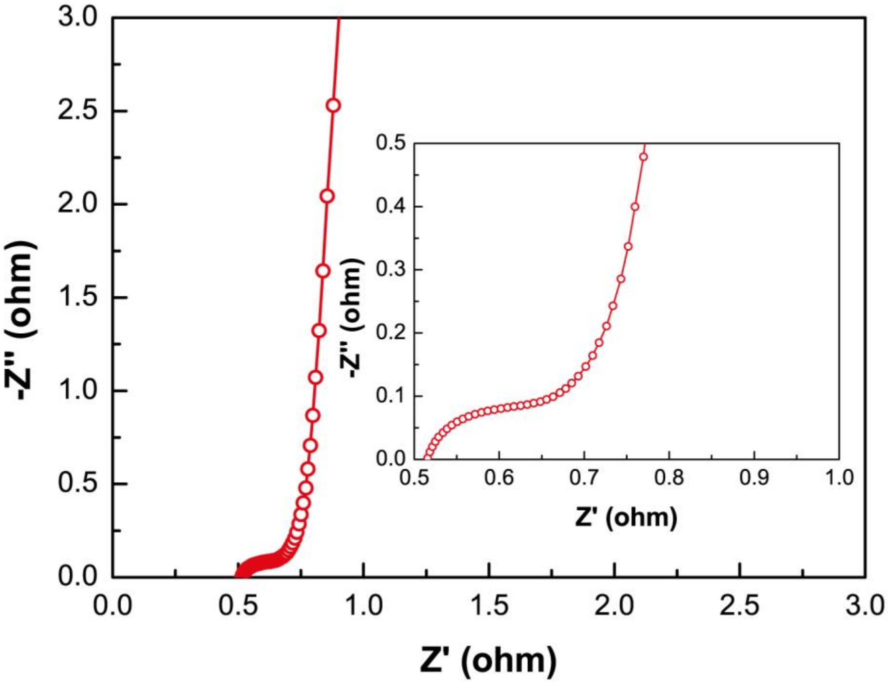

Figure S11. Nyquist plots of $MnCo_2S_4/FeCo_2S_4$/N-CMF//AC HSC measured in the frequency range from 10 mHz to 100 kHz with an AC voltage of 10 mV.

Table S1 Comparison of the electrochemical performance between $MnCo_2S_4/FeCo_2S_4$/N-CMF composite foam and other electrode materials reported in literatures.

Electrode materials	Specific capacitance	Rate capability	Potential window (V)	Electrolyte	References
$MnCo_2S_4/FeCo_2S_4$/N-CMF	2806 F g^{-1} at 1 A g^{-1}	64% from 1 to 20 A g^{-1}	0-0.5	3 M KOH	This work
$NiCo_2S_4$ polyhedron architectures	1296 F g^{-1} at 1 A g^{-1}	93.2% from 1 to 10 A g^{-1}	0-0.5	1 M KOH	1
$CuCo_2S_4$ nanograss arrays	1852 F g^{-1} at 2 A g^{-1}	51.2% from 2 to 30 A g^{-1}	-0.1-0.4	2 M KOH	2
$Zn_{0.76}Co_{0.24}S/Ni(OH)_2$	2156 F g^{-1} at 1 A g^{-1}	71% from 1 to 20 A g^{-1}	0-0.4	6 M KOH	3
$MnCo_2O_4@Ni(OH)_2$ belt-based core-shell nanoflowers	2154 F g^{-1} at 5 A g^{-1}	32.5 % from 5 to 50 A g^{-1}	0-0.45	2 M KOH	4
$NiCo_2S_4$ ball-in-ball	1036 F g^{-1} at 1 A g^{-1}	68.1% from 1 to 20 A g^{-1}	-0.1-0.45	6 M KOH	5
$FeCo_2S_4$-$NiCo_2S_4$ nanotubes	1519 F g^{-1} at 5 mA cm^{-2}	85.1 % from 5 to 40 mA cm^{-2}	0-0.6	3 M KOH	6
$FeCo_2S_4$-tube arrays	2411 F g^{-1} at 5 mA cm^{-2}	72 % from 5 to 40 mA cm^{-2}	0-0.4	3 M KOH	7
$NiCo_2S_4$/NCF	1231 F g^{-1} at 2 A g^{-1}	71.2% from 2 to 20 A g^{-1}	-0.1-0.5	6 M KOH	8
$MnCo_2S_4$ hollow tubular structures	1203 F g^{-1} at 2 A g^{-1}	80% from 2 to 20 A g^{-1}	0-0.5	2 M KOH	9

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