Hollow Mesoporous Hetero-$NiCo_2S_4/Co_9S_8$ Submicro-Spindles: Unusual Formation and Appealing Pseudocapacitance towards Hybrid Supercapacitors

Linrui Hou [a], Yaoyao Shi [a], Siqi Zhu [a], Muhammad Rehan [a], Gang Pang [a, b], Xiaogang Zhang [b], Changzhou Yuan [a, *]

a. School of Materials Science & Engineering, Anhui University of Technology, Ma'anshan, 243002, P. R. China *Email: ayuancz@163.com

b. College of Material Science & Engineering, Nanjing University of Aeronautics & Astronautics, Nanjing, 210016, P. R. China

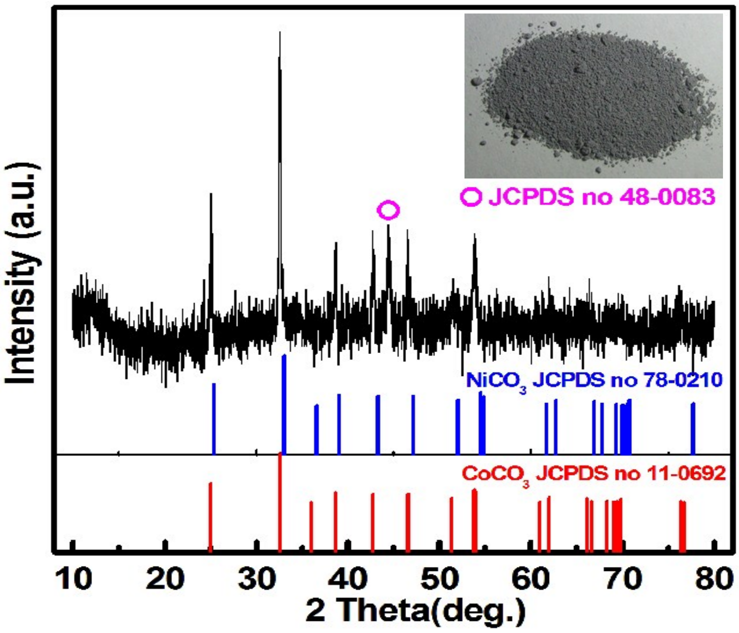

Fig. S1. Typical WAXRD pattern (b) of the as-obtained NCCO precursor. The red and blue vertical lines for the standard JCPDS profiles of $NiCO_3$ (JCPDS no. 78-0210) and $CoCO_3$ (JCPDS no. 11-0692). And the hollow magenta circle for the $Co(CO_3)_{0.5}(OH){\cdot}0.11H_2O$ (JCPDS no. 48-0083), the inset for the optical image of the as-obtained NCCO powder

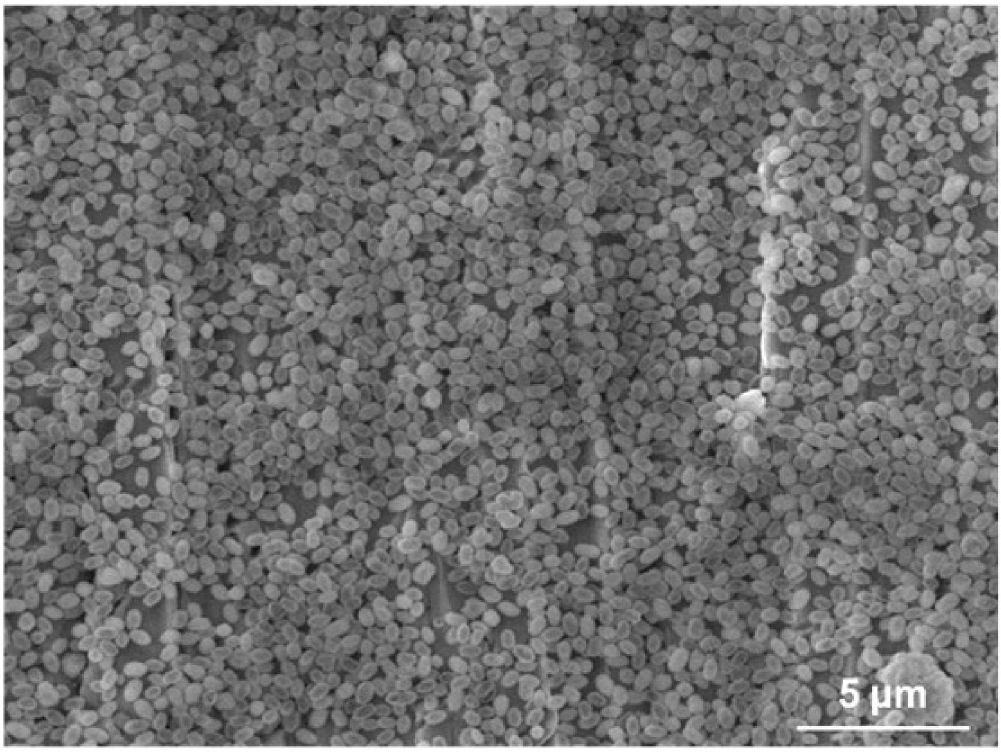

Fig. S2. Typical FESEM of the NCCO intermediate

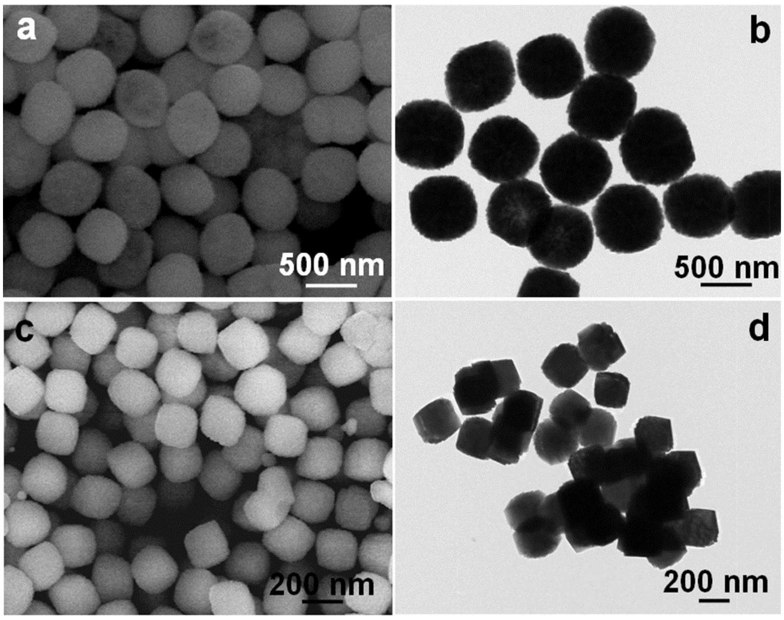

Fig. S3. Typical FESEM (a, c) and TEM (b, d) images of the intermediate NCCO-20 (a, b) and NCCO-30 (c, d)

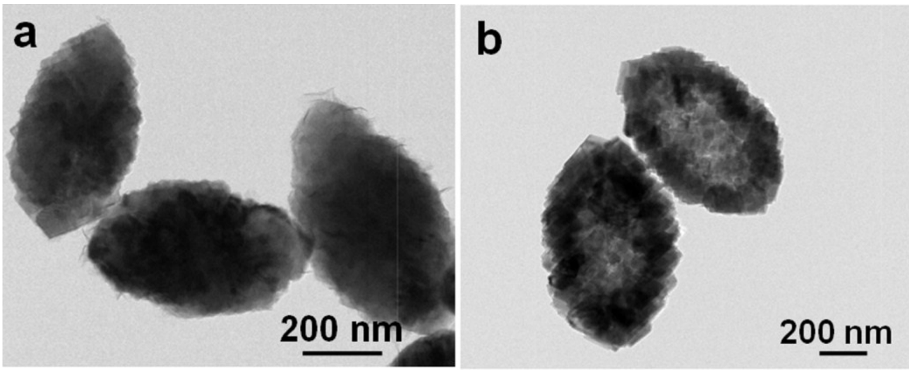

Fig. S4. TEM image of the (a) NCCO-10 and (b) NCCO-25h samples

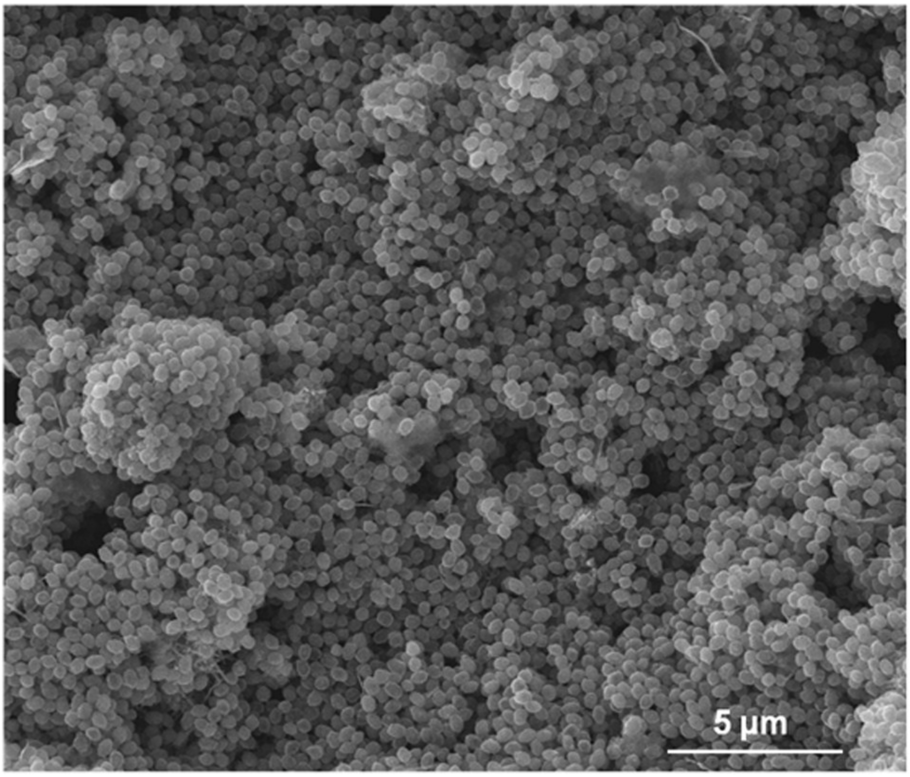

Fig. S5. Typical FESEM image for the resultant NCCS sample

Table S1 Electrochemical comparisons between the hollow hetero-NCCS submicro-spindles with other $NiCo_2S_4$-based electrodes and Co_9S_8 electrodes in three-electrode systems

$NiCo_2S_4$-based electrodes	SCs (F g^{-1}) / current density (A g^{-1})	Loadings (mg cm^{-2}) of electroactive materials	Ref.
hollow hetero-NCCS submicro-spindles	749 / 4.0 660 / 10.0	5.0	This work
Mesoporous $NiCo_2S_4$ nanosheets	744 / 1.0	1.0	[1]
$NiCo_2S_4$ nanoplates	437 / 4.0	2.4	[2]
$NiCo_2S_4$ nano-aggregates	592 / 0.5	2.5 ~ 3.5	[3]
$NiCo_2S_4$ nanotubes	738 / 4.0	4.2	[4]
$NiCo_2S_4$ nanosheets	653 / 10.0	0.8	[5]
$NiCo_2S_4/Ni_xCo_{9-x}S_8$	540 / 9.0	4.0	[6]
$Ni_{0.24}Co_{2.58}S_4$ microflowers	379 / 0.5	unknown	[7]
$NiCo_2S_4$ nanotubes	665 / ~0.93	4.3	[8]
$NiCo_2S_4$@30% graphene	~620 / 1.0	5.0	[9]
$NiCo_2S_4$ nanosheets	~550 / 5.0	4.0 ~ 6.0	[10]
$NiCo_2S_4$ nanoboxes	~481 / 10.0	5.0	[11]
Co_9S_8 nanoparticles	~350 / 5.0 mV s^{-1}	2.0	[12]
Flower-like Co_9S_8	~397 / 2.0	10.0	[13]
Co_9S_8 nanotubes	~261.3 / 2.0	Unknown	[14]
Co_9S_8 nanorod arrays	~450 / 5.0	0.6	[15]
Co_9S_8 nanorod arrays	~783.3 / 5.0 mV s^{-1}	3.0	[16]

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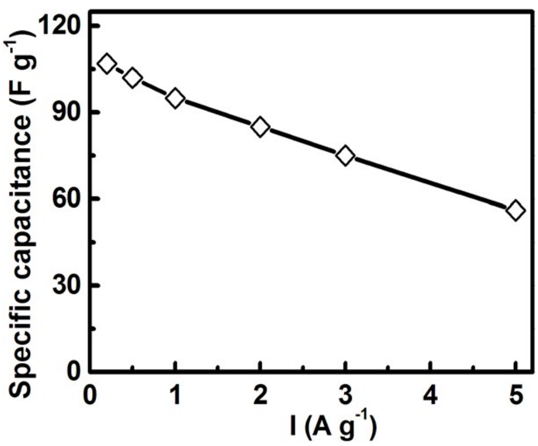

Fig. S6 SCs of the hybrid AC//hollow hetero-NCCS device as a function of current density

Table S2 Electrochemical comparisons between the AC//hollow hetero-NCCS submicro-spindles asymmetric device with other hybrid ESCs

Asymmetric ESCs	Specific energy densities and power densities	Ref.
AC//hollow hetero-NCCS submicro-spindles	17.5 Wh kg^{-1} at 3.75 kW kg^{-1} 33.5 Wh kg^{-1} at 150 W kg^{-1}	This work
AC//$NaMnO_2$	13.2 Wh kg^{-1} at 1.0 kW kg^{-1}	[1]
AC//MnO_2 nanorods	17.0 Wh kg^{-1} at 2.0 kW kg^{-1}	[2]
AC//$LiTi_2(PO_4)_3$	15.0 Wh kg^{-1} at 1.0 kW kg^{-1}	[3]
AC//$K_{0.27}MnO_2 \cdot 0.6H_2O$	17.6 Wh kg^{-1} at 2.0 kW kg^{-1}	[4]
AC//$Ni(OH)_2$	10.5 Wh kg^{-1} at 690 W kg^{-1}	[5]
Fe_2O_3//MnO_2	7.0 Wh kg^{-1} at 820 W kg^{-1}	[6]
AC//Co_3O_4-rGO	13.4 Wh kg^{-1} at 2.1 kW kg^{-1}	[7]
AC//$NiCo_2O_4$	14.7 Wh kg^{-1} at 175 W kg^{-1}	[8]
graphene/NF//$Cu_{1.79}Co_{0.21}$ CH/NF	21.5 Wh kg^{-1} at 200 W kg^{-1}	[9]
AC//Ni_3S_2@CNTs	19.8 Wh kg^{-1} at 798 W kg^{-1}	[10]
AC//Co_3O_4@MnO_2	17.7 Wh kg^{-1} at 600 W kg^{-1}	[11]
Carbon//NiO	15.0 Wh kg^{-1} at 447 W kg^{-1}	[12]
AC//$NiCo_2O_4$-graphene	19.5 Wh kg^{-1} at 100 W kg^{-1}	[13]
AC//$CoMoO_4$-$NiMoO_4 \cdot xH_2O$	24.95 Wh kg^{-1} at 164.5 W kg^{-1}	[14]
AC//amorphous $NiWO_4$	25.3 Wh kg^{-1} at 200 W kg^{-1}	[15]
AC//$NiMoO_4$-$CoMoO_4 \cdot xH_2O$	28.0 Wh kg^{-1} at 100 W kg^{-1}	[16]

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