Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Electronic Supplementary Information

Hierarchical nanosheet-based $CoMoO_4$-$NiMoO_4$ nanotubes for applications in asymmetric supercapacitor and oxygen evolution reaction

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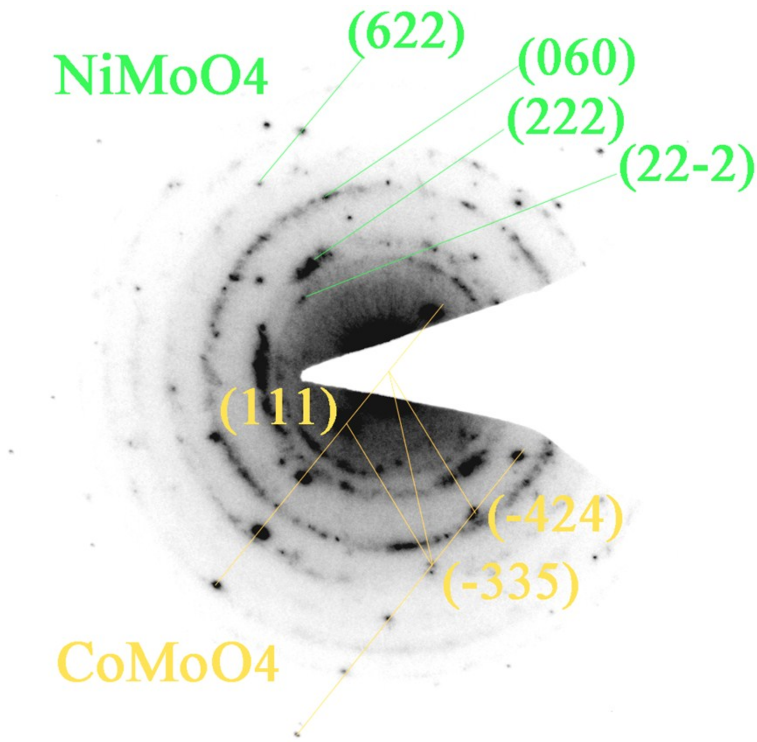

Figure S1 The magnified SAED pattern of NCMNT-3.

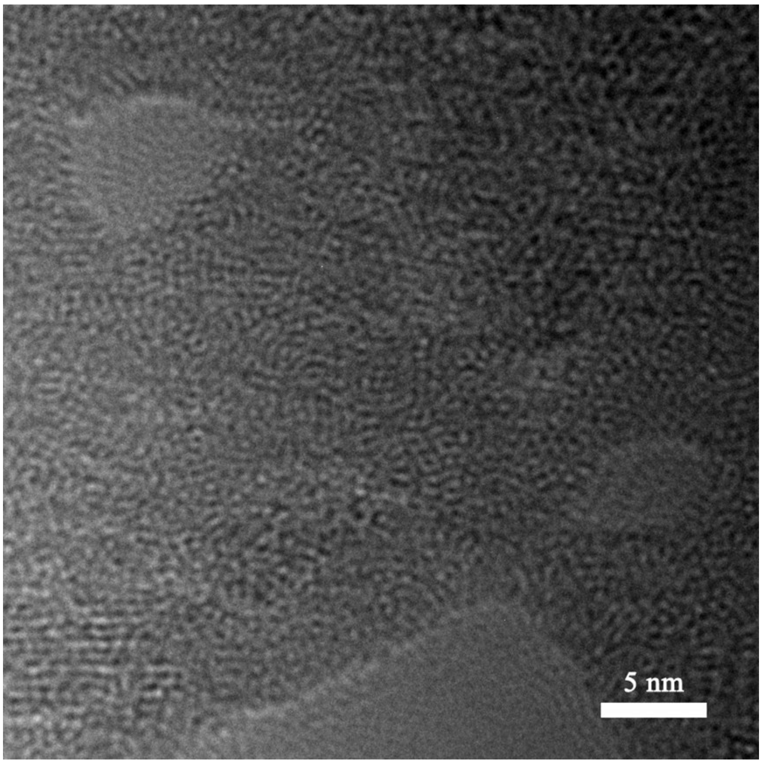

Figure S2 HRTEM images of NCMNT-3.

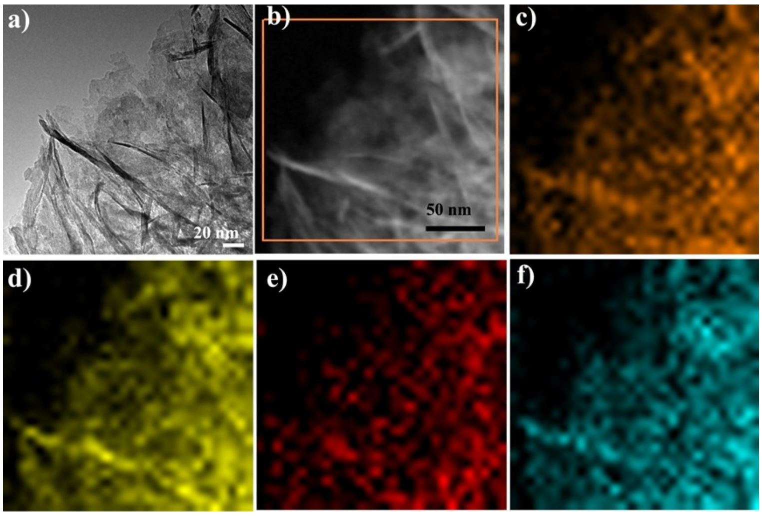

Figure S3 a) TEM image, b) STEM image, c) Mo mapping, d) Ni mapping, e) Co mapping, and f) O mapping.

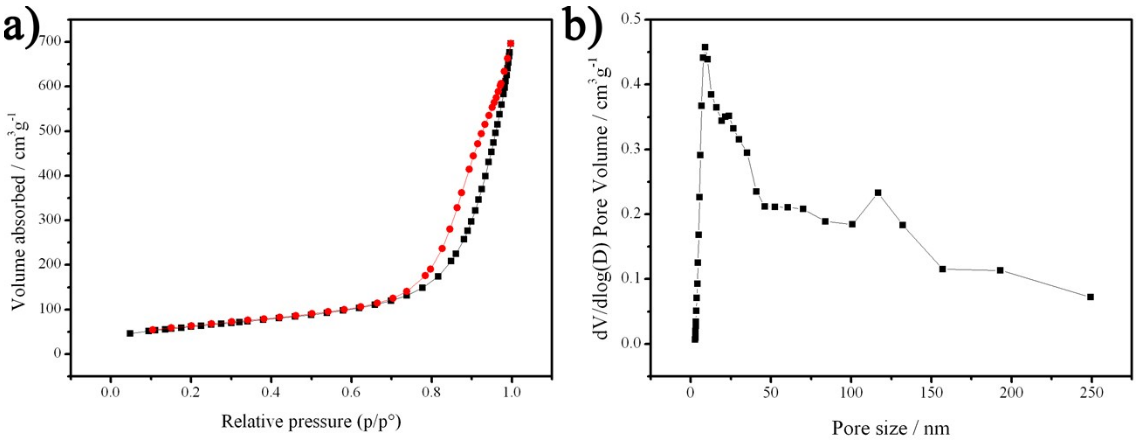

Figure S4 (a) Nitrogen adsorption and desorption isotherms and (b) the corresponding pore-size distribution calculated by BJH method from the desorption branch of hierarchical NCMNT-3.

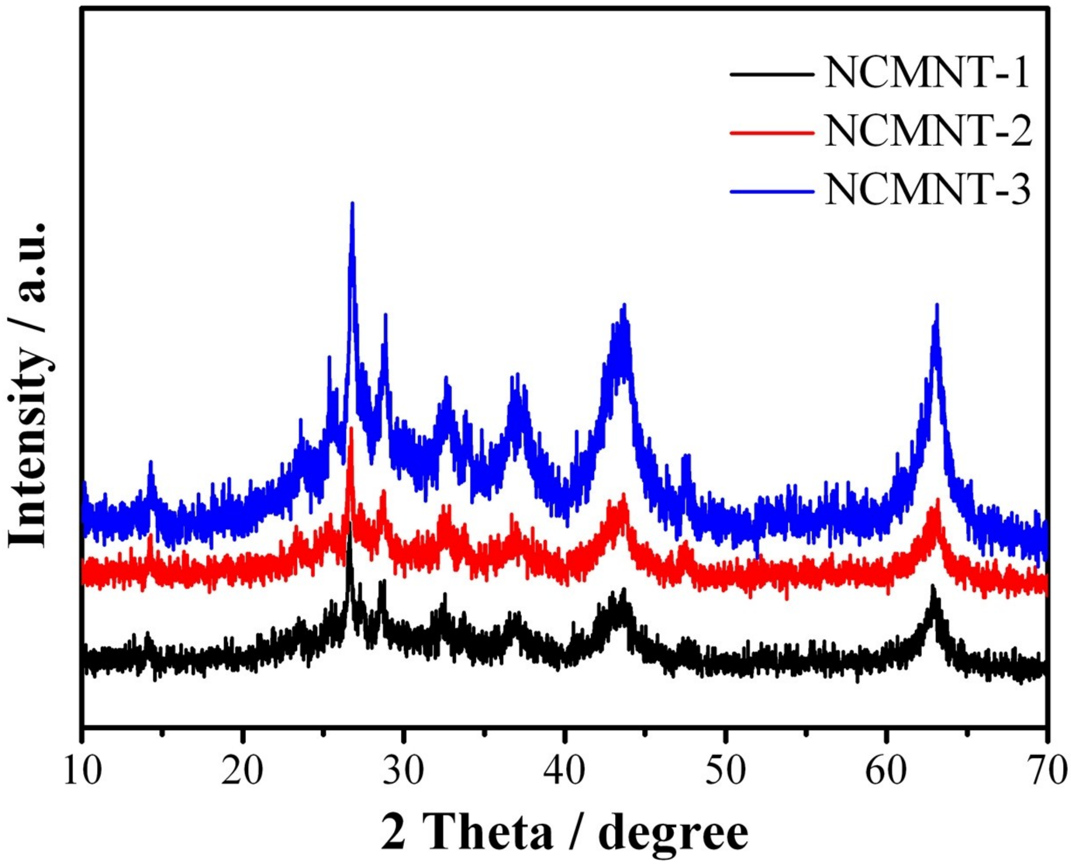

Figure S5 XRD patterns of the hierarchical NCMNT-1，NCMNT-2 and NCMNT-3.

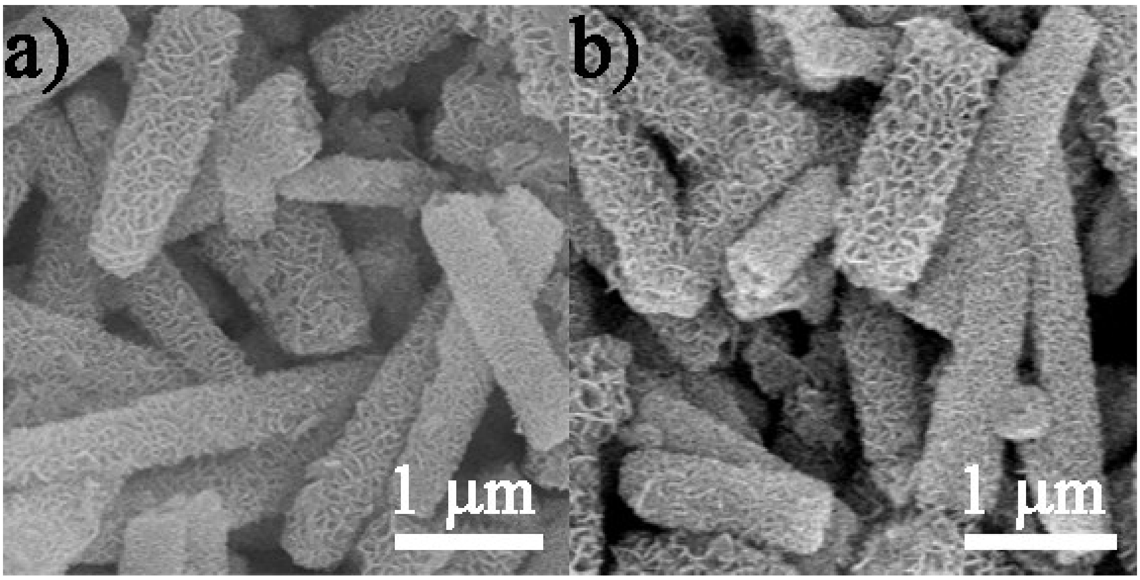

Figure S6 SEM images of the hierarchical nanosheet-based nanotubes with different added weight of cobalt chloride. (a) NCMNT-1 and (b) NCMNT-2.

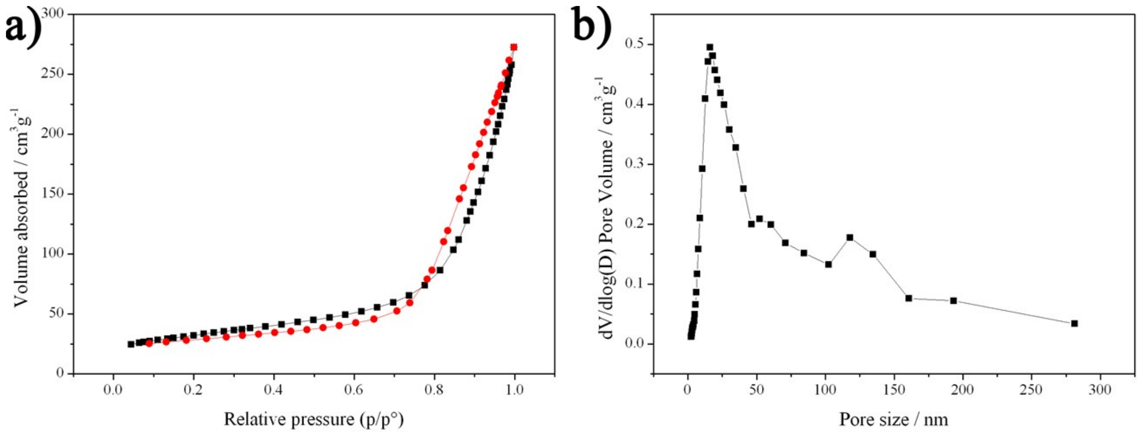

Figure S7 (a) Nitrogen adsorption and desorption isotherms and (b) the corresponding pore-size distribution calculated by BJH method from the desorption branch of hierarchical NCMNT-1.

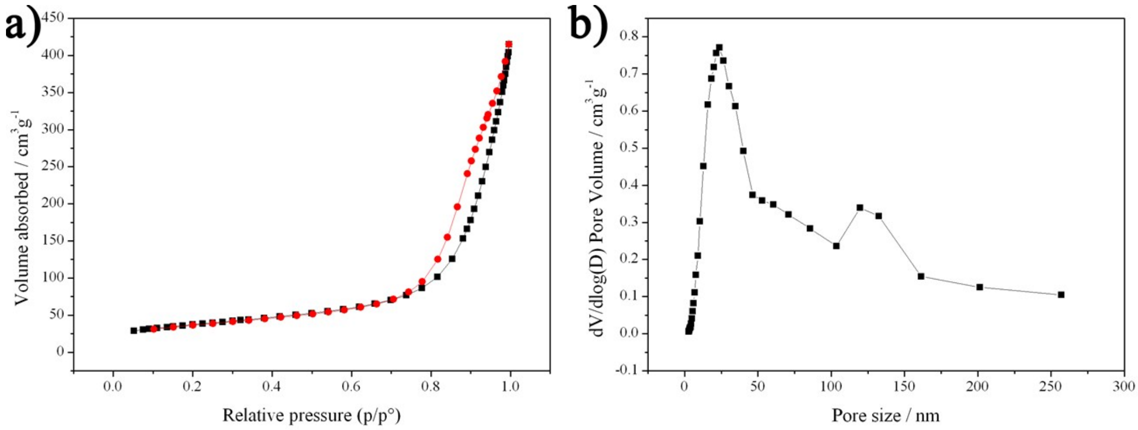

Figure S8 (a) Nitrogen adsorption and desorption isotherms and (b) the corresponding pore-size distribution calculated by BJH method from the desorption branch of hierarchical NCMNT-2.

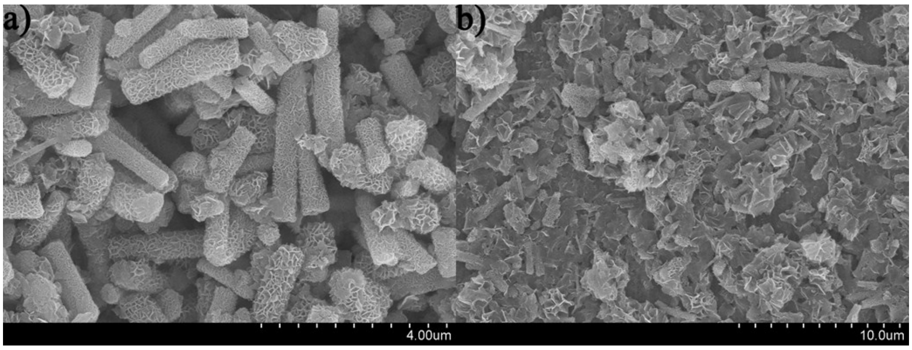

Figure S9 (a) SEM image of the sample obtained as the added weight of cobalt chloride was 95 mg and (b) SEM image of the sample obtained as the added weight of cobalt chloride was 590 mg.

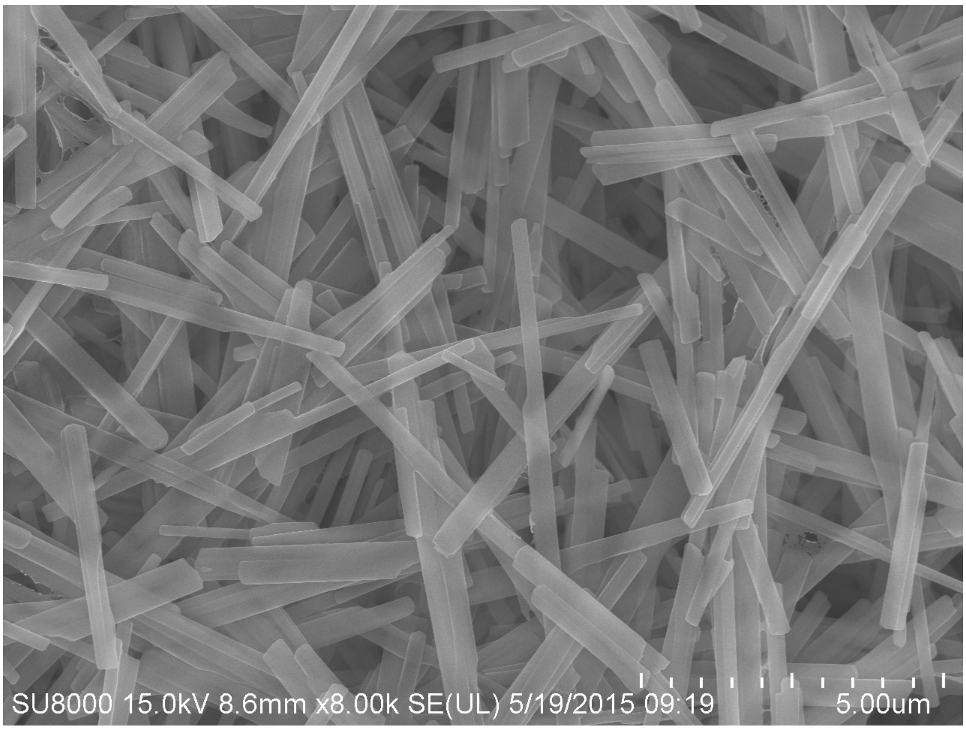

Figure S10 SEM image of the sample without nickel acetate.

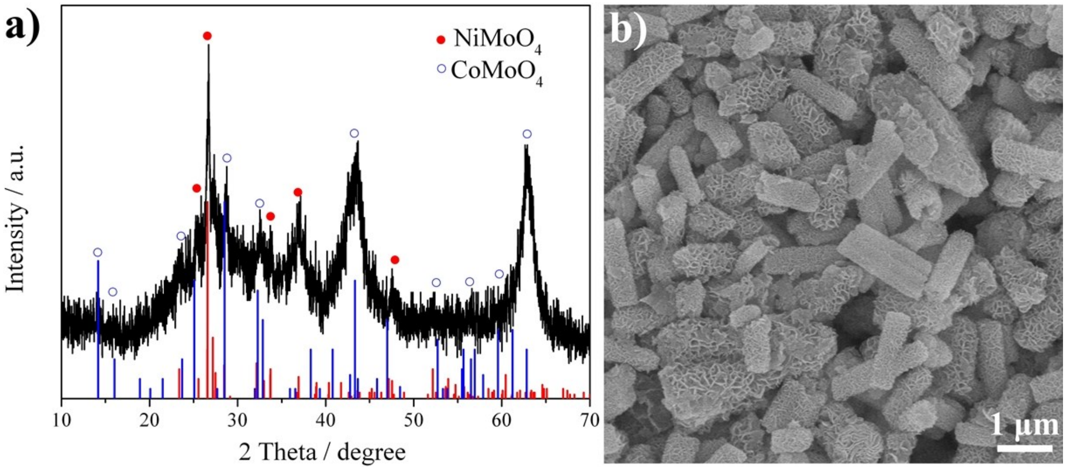

Figure S11 a) XRD and b) SEM image of the sample obtained as cobalt chloride was replaced with cobalt acetate. The experimental conditions are similar to those of synthesis of NCMNT-3, but cobalt chloride was replaced with cobalt acetate (the molar quantity molar 68 mg).

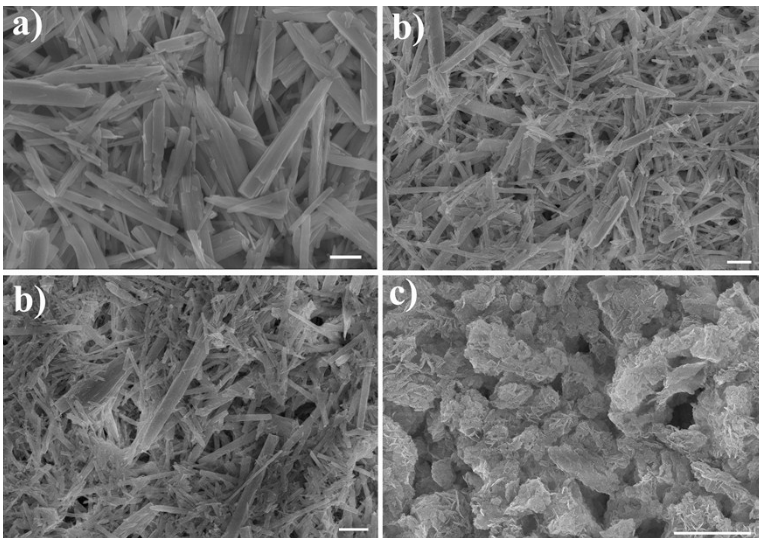

Figure S12 SEM image of the samples obtained using MoO_3 nanorods and cobalt acetate as precursors in the water–ethanol (volume ratio = 1: 1) system and the hydrothermal treatment proceeded at 90°C for 5 h. a) Weight of cobalt acetate is 68 mg, b) weight of cobalt acetate is 78 mg, c) weight of cobalt acetate is 78 mg, and d) weight of cobalt acetate is 620 mg. The scar bars: 2 μm.

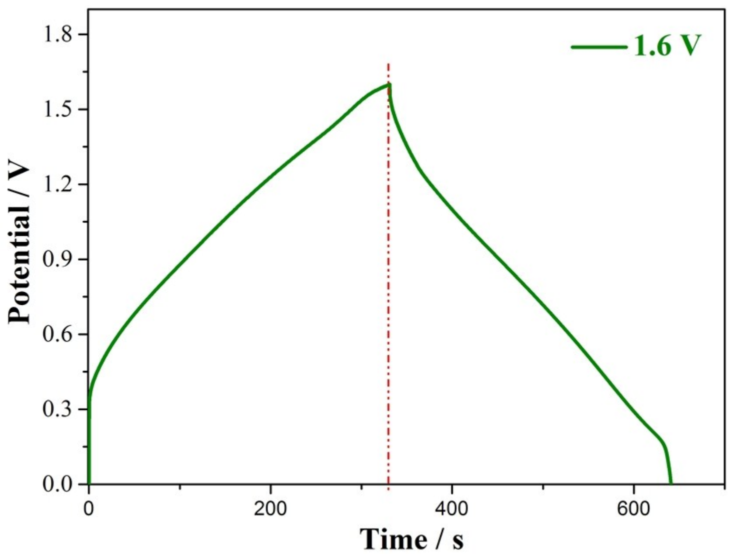

Figure S13 The galvanostatic charge–discharge curves at a current of 5 mA under a potential of 1.6 V in 2 M KOH solution.

Table S1 Comparison of the specific capacitances of NCMNTs with literature data.

	Special capacitance (F g^{-1}) at different current density (A g^{-1})							**Ref.**
	1 A g^{-1}	**2 A g^{-1}**	**3 A g^{-1}**	**5 A g^{-1}**	**8 A g^{-1}**	**10 A g^{-1}**	**20 A g^{-1}**	
NMNT	887	785	714	603	510	490	136	This work
NCMNT-1	865	839	839	768	728	707	642	This work
NCMNT-2	1307	1219	1172	1109	1047	1018	878	This work
NCMNT-3	1424	1317	1262	1189	1089	1040	828	This work
Layered $H_2Ti_6O_{13}$ –Nanowires	<800	684	—	<650		504		4
Vanadium Nitride	1340 (2 mV s^{-1})	—	—	—	—	—	554 (100mV s^{-1})	8
Graphene/MnO_2 Nanostructured Textiles	315 (2 mV s^{-1})	—	—	—	—	—	—	15
Carbon nanofiber/MnO_2 coaxial nano-cables	311 (2 mV s^{-1})	—	—	—	—	—	—	16
$Co_{0.56}Ni_{0.44}$ Oxide Nanoflake	1227	—	—	—	—	—	—	17
$NiMoO_4 \cdot xH_2O$ nanorods	1136 (5 mA cm^{-2})	960 (10 mA cm^{-2})	—	850 (20 mA cm^{-2})	778 (30 mA cm^{-2})	725 (40 mA cm^{-2})	688 (50 mA cm^{-2})	18
$NiMoO_4 \cdot xH_2O$ nanoclusters	680	590	—	412	This work	393	—	19
$CoMoO_4$ nanorods	286 (5 mA cm^{-2})	246 (10 mA cm^{-2})	—	219 (20 mA cm^{-2})	202 (30 mA cm^{-2})	192 (40 mA cm^{-2})	173 (50 mA cm^{-2})	20
$NiMoO_4$ nanotubes	864	777	682	605	—	—	—	21
$MnMoO_4$–$CoMoO_4$ nanowires	187.1	<175	<140	—	—	—	<80	22
$CoMoO_4$–$NiMoO_4 \cdot xH_2O$ bundles	1027 (1.26 A g^{-1})	988 (2.5 A g^{-1})	—	916 (6.25 A g^{-1}	—	826 (12.6 A g^{-1})	750 (25 A g^{-1})	23
ß-$NiMoO_4$–$CoMoO_4 \cdot xH_2O$	1472 (5 mA	<1350 (10 mA	<1200 (15	<1000 (20	—	—	—	24

	cm^{-2})	cm^{-2})	mA cm^{-2})	mA cm^{-2})				

Table S2 Comparison of the energy density and power density of AC//NCMNT-3 with literature data..

	Energy density (W h kg^{-1})/Power density (W Kg^{-1})		**Refs.**
AC//NCMNT-3	33 /375	25.3 /1500	This work
RGO–RuO_2//RGO–PANI	26.3 / (NA)	—	10
AC//$Co_{0.56}Ni_{0.44}$ Oxide Nanoflake	34.5 /133	22.5 /1333.3 /	17
AC//$NiMoO_4 \cdot xH_2O$ nanorods	34.4/65	24.9 /1650	18
AC//$CoMoO_4$–$NiMoO_4 \cdot xH_2O$ bundles	25 /165	15.5/1650	23
AC//ß-$NiMoO_4$–$CoMoO_4 \cdot xH_2O$	28/100	18 /1000	24

Table S3 Comparison of the OER activity of NCMNT-3 with literature data in the alkaline media.

	Potential (V vs RHE) at different current density (mA cm^{-2})			Tafel slope (mv/dec)	Ref.
	J_a=10 mA cm^{-2}	J_a=100 mA cm^{-2}	J_a=300 mA cm^{-2}		
NCMNT-3	1.530	1.585	1.617	68	This work
NCMNT-2	1.557	1.638	1.691	94	This work
NCMNT-1	1.570	1.655	1.730	98	This work
NMNT	1.589	1.675	1.770	126	This work
N/C materials	1.610 ± 0.01（PH=13）	—	—	—	27
Ni_3N nanosheets	1.486	1.580 (J_a=52.3 mA cm^{-2})	1.730 (J_a=153.2 mA cm^{-2})	45	31
Surface-Oxidized Multiwall Carbon Nanotubes	1.580	—	—	41	32
α-$Ni(OH)_2$ spheres	1.561 （0.1 M KOH ）	—	—	42	33
$FeMoO_4$	—	658±5 mV vs Hg/HgO≈1.588 V vs RHE	702±6 mV vs Hg/HgO ≈1.632 V vs RHE	37	35
$CoMoO_4$	—	670±8 mV vs Hg/HgO≈1.6 V vs RHE	723±17 mV vs Hg/HgO≈1.653 V vs RHE	44	35
$NiMoO_4$	—	685±3 mV vs Hg/HgO≈1.615 V vs RHE	740±10 mV vs Hg/HgO ≈1.67 V vs RHE	42	35
$NiMoO_4$	—	—	—	70	36
hollow Co_3O_4 microspheres	1.630（PH=13）	—	—	—	37

Graphene-Co_3O_4	1.543	—	—	56	38
Co_3O_4/$NiCo_2O_4$ DSNCs	1.570	—	—	88	39
Mn3O4/$CoSe_2$ Nanocomposite	1.680 （0.1 M KOH）	—	—	49	40
PNG-NiCo	1.603 (5 mA cm^{-2}) 1.664 (16.5 mA cm^{-2})	1.794 (21.1 mA cm^{-2})	—	156	41
Co_3O_4-35	1.706	—	—	—	42
Co_3O_4/SWNTs	1.824	—	—	104	43
Mesoporous Co_3O_4 Nanoflakes	1.610	—	—	48	44
NG-NiCo	—	—	1.630 (145.3 mA cm^{-2}) （0.1 M KOH）	614	45
$Zn_xCo_{3-x}O_4$-1:3	1.550	—	—	51	46
Ni-Co_3O_4-A	≈1.760（0.1 M KOH）	—	—	—	47
5.9 nm Co_3O_4	1.558	1. 660	1.730 (200 mA cm^{-2})	50	48