Electronic Supplementary Information

Hierarchical $NiMoO_4@Co_3V_2O_8$ Hybrid Nanorod/Nanosphere Clusters as Advanced Electrodes for High-performance Electrochemical Energy Storage

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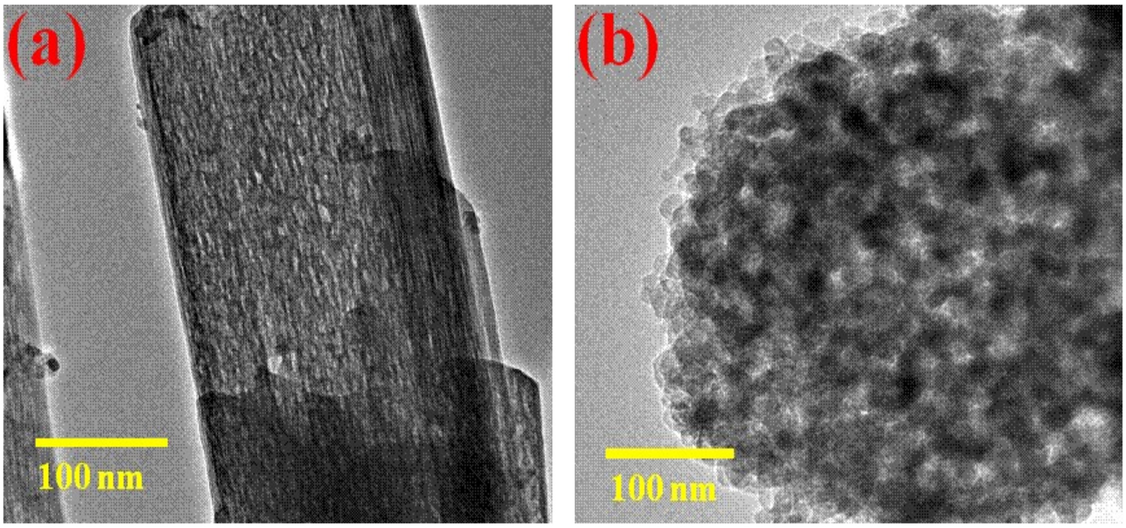


Fig. S1. TEM image of $NiMoO_4$ nanorod (a) and $Co_3V_2O_8$ nanosphere (b).

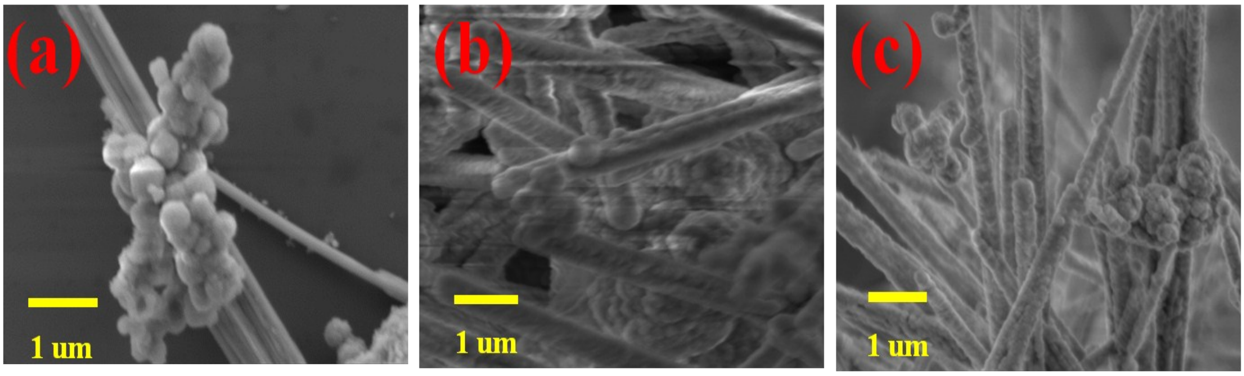


Fig. S2. SEM images of the NMO@CVO-2 (a), NMO@CVO-4 (b) and NMO@CVO-16 (c), respectively.

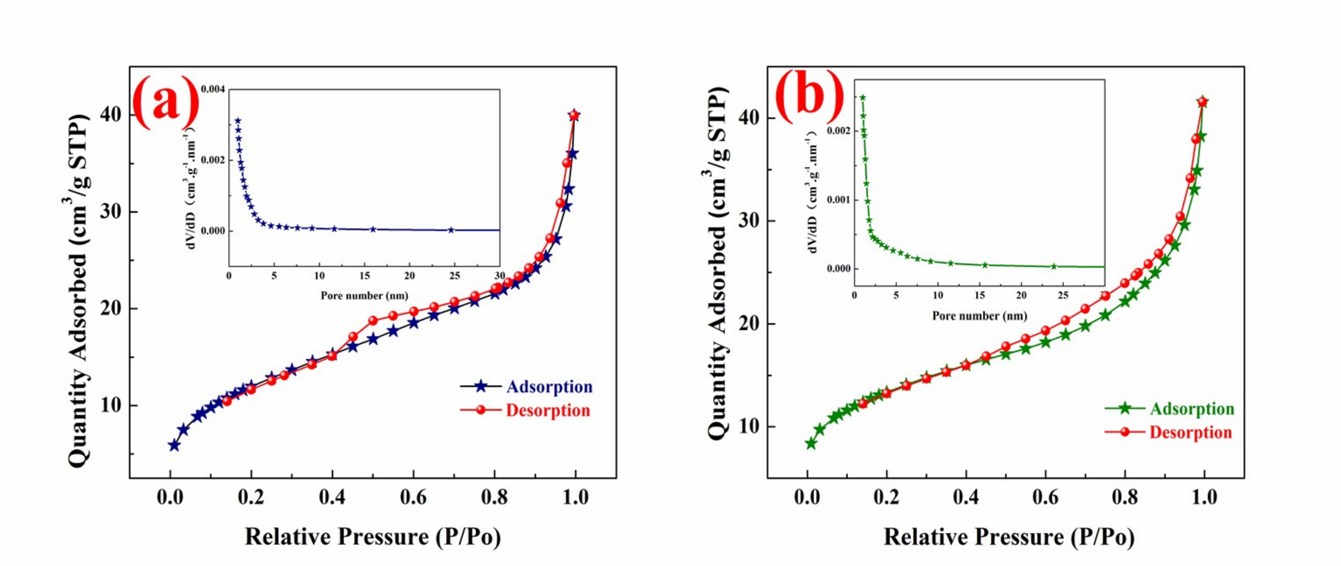


Fig. S3. The nitrogen adsorption-desorption isotherms and BJH pore size distribution plot (inset) of the NMO (a) and CVO (b).

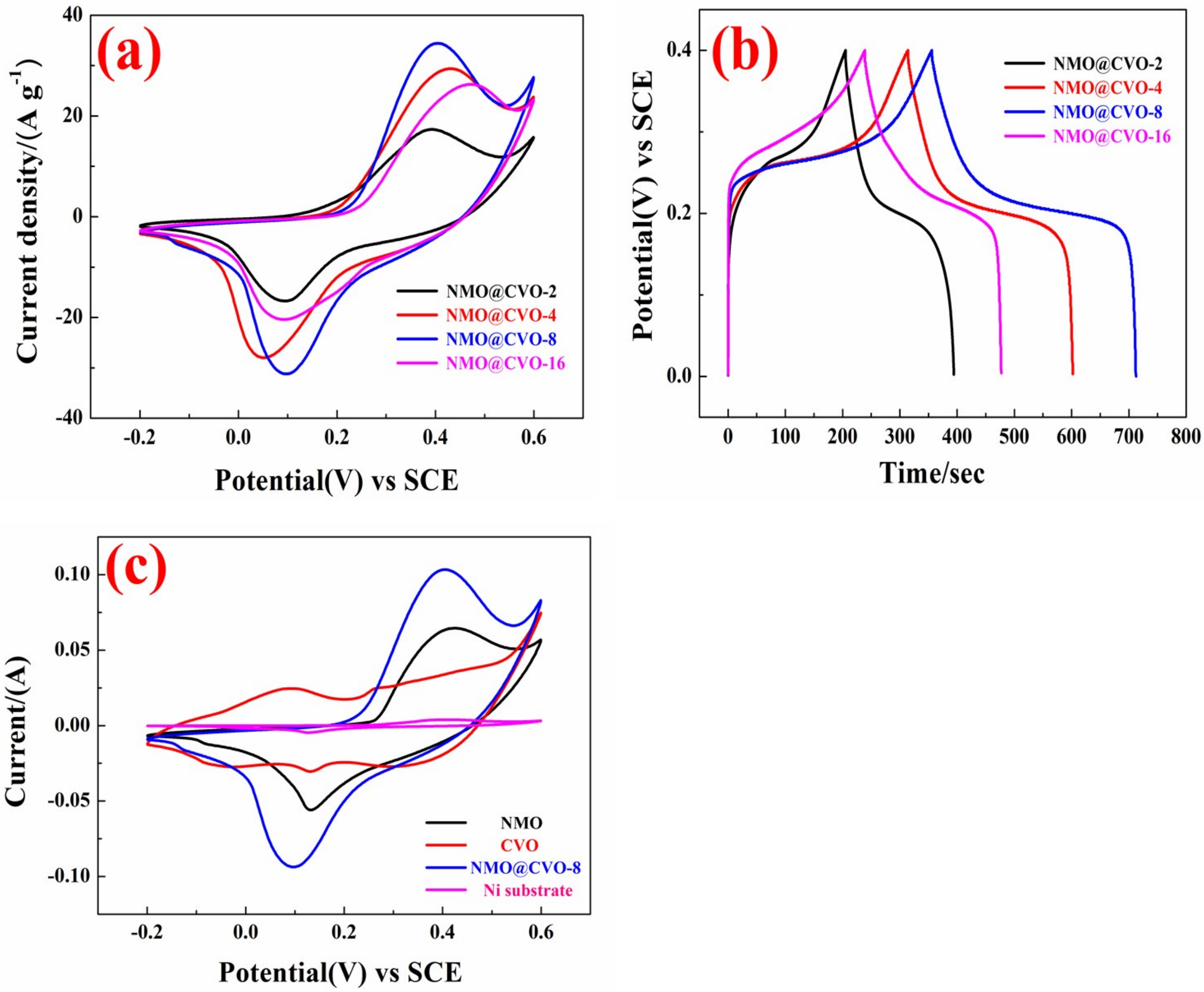
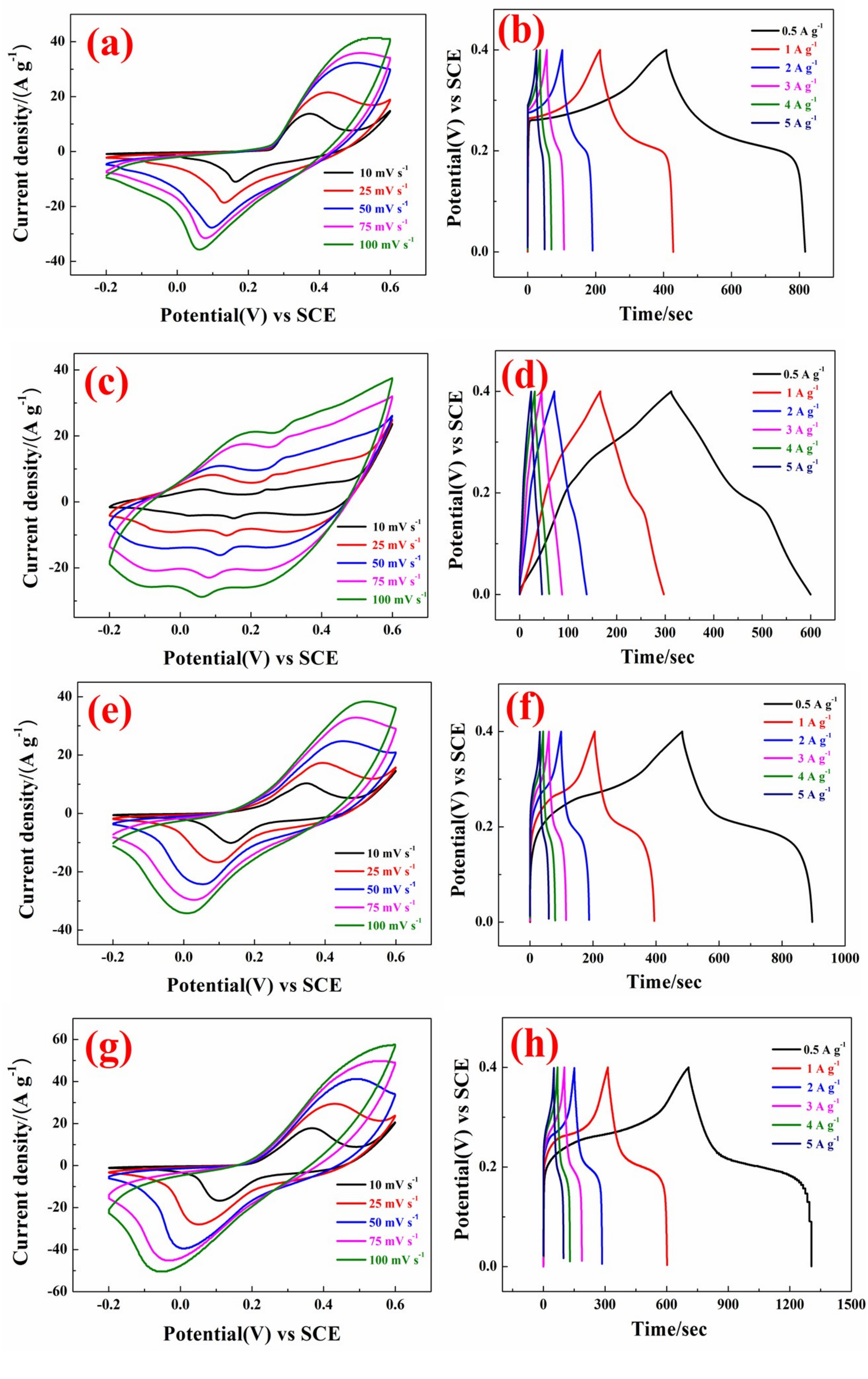


Fig. S4. (a) Cyclic voltammogram (CV) curves comparison of NMO@CVO-2, NMO@CVO-4, NMO@CVO-8 and NMO@CVO-16 electrodes at a scan rate of 25 mV s^{-1}; (b) galvanostatic charge-discharge (GCD) curves comparison of NMO@CVO-2, NMO@CVO-4, NMO@CVO-8 and NMO@CVO-16 electrodes at a current density of 1 A g^{-1}; (c) CV curves comparison of NMO, CVO, NMO@CVO-8 and Ni substrate at a scan rate of 25 mV s^{-1}.



(a)
Current density/(A g-1)
Potential(V) vs SCE
10 mV s-1
25 mV s-1
50 mV s-1
75 mV s-1
100 mV s-1
(b)
Potential(V) vs SCE
Time/sec
0.5 A g-1
1 A g-1
2 A g-1
3 A g-1
4 A g-1
5 A g-1
(c)
Current density/(A g-1)
Potential(V) vs SCE
10 mV s-1
25 mV s-1
50 mV s-1
75 mV s-1
100 mV s-1
(d)
Potential(V) vs SCE
Time/sec
0.5 A g-1
1 A g-1
2 A g-1
3 A g-1
4 A g-1
5 A g-1
(e)
Current density/(A g-1)
Potential(V) vs SCE
10 mV s-1
25 mV s-1
50 mV s-1
75 mV s-1
100 mV s-1
(f)
Potential(V) vs SCE
Time/sec
0.5 A g-1
1 A g-1
2 A g-1
3 A g-1
4 A g-1
5 A g-1
(g)
Current density/(A g-1)
Potential(V) vs SCE
10 mV s-1
25 mV s-1
50 mV s-1
75 mV s-1
100 mV s-1
(h)
Potential(V) vs SCE
Time/sec
0.5 A g-1
1 A g-1
2 A g-1
3 A g-1
4 A g-1
5 A g-1

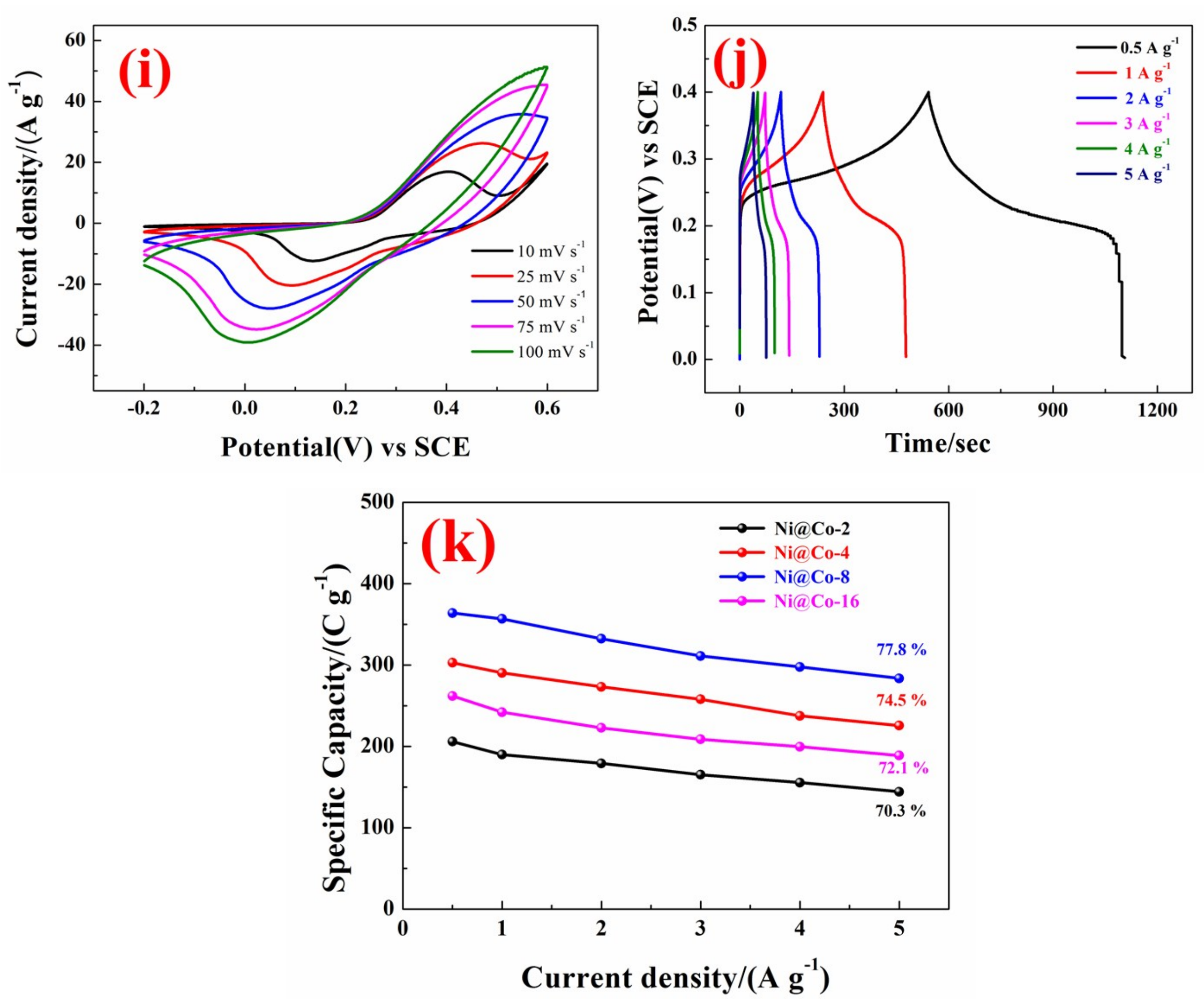


Fig. S5. (a), (c), (e), (g), (i) CV curves of NMO, CVO, NMO@CVO-2, NMO@CVO-4 and NMO@CVO-16, respectively, at the scan rate between 10 and 100 mV s $^{-1}$; (b), (d), (f), (h), (j) GCD curves of NMO, CVO, NMO@CVO-2, NMO@CVO-4 and NMO@CVO-16, respectively, at the current densities between 0.5 and 5 A g $^{-1}$; (k) The rate performance with specific capacitance values calculated from GCD curves of NMO@CVO-2, NMO@CVO-4, NMO@CVO-8 and NMO@CVO-16, respectively.

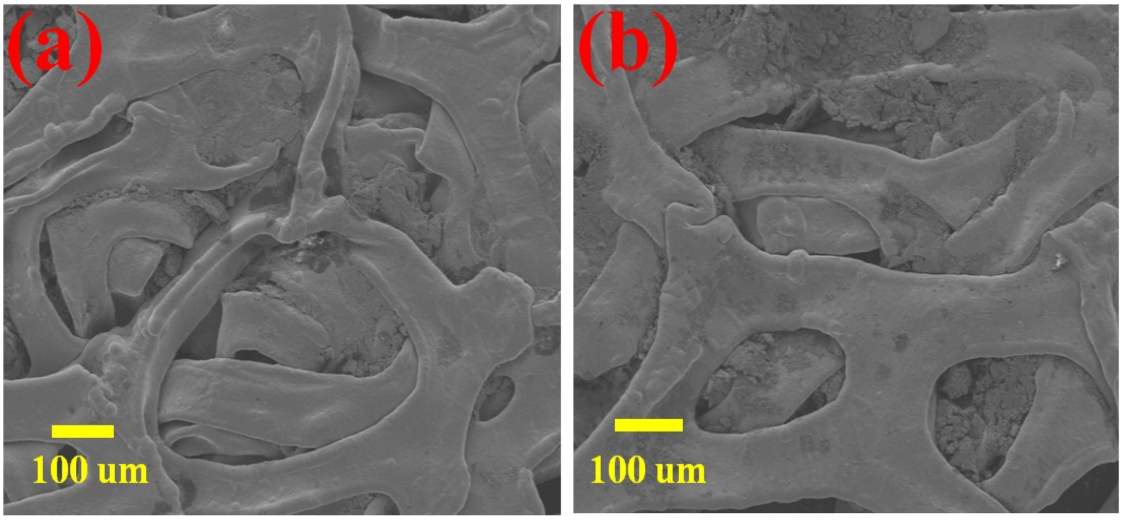


Fig. S6. the morphology of NMO@CVO-8 electrode before (a) and after (b) cycling.

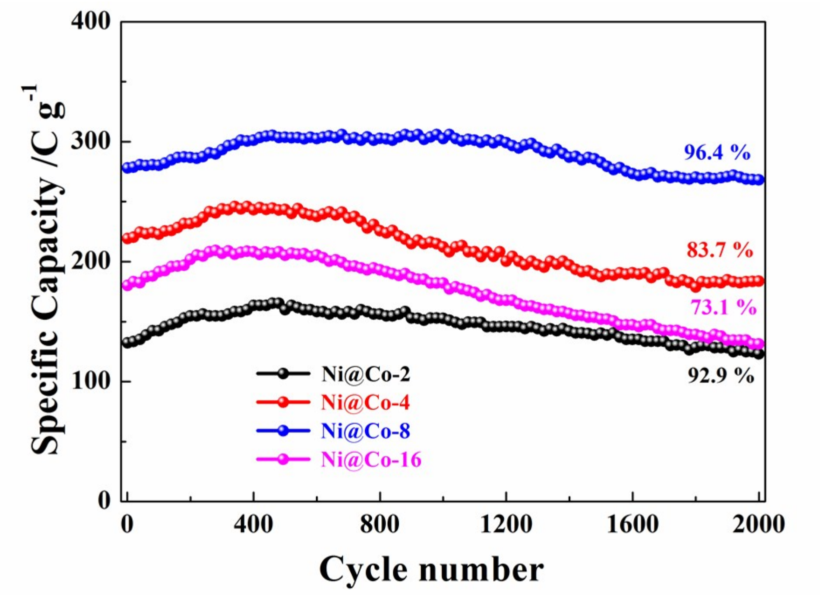


Fig. S7. Cycling cycling performance during 2000 cycles at a current density of 3 A g $^{-1}$ for NMO@CVO-2, NMO@CVO-4, NMO@CVO-8 and NMO@CVO-16 electrodes, respectively.

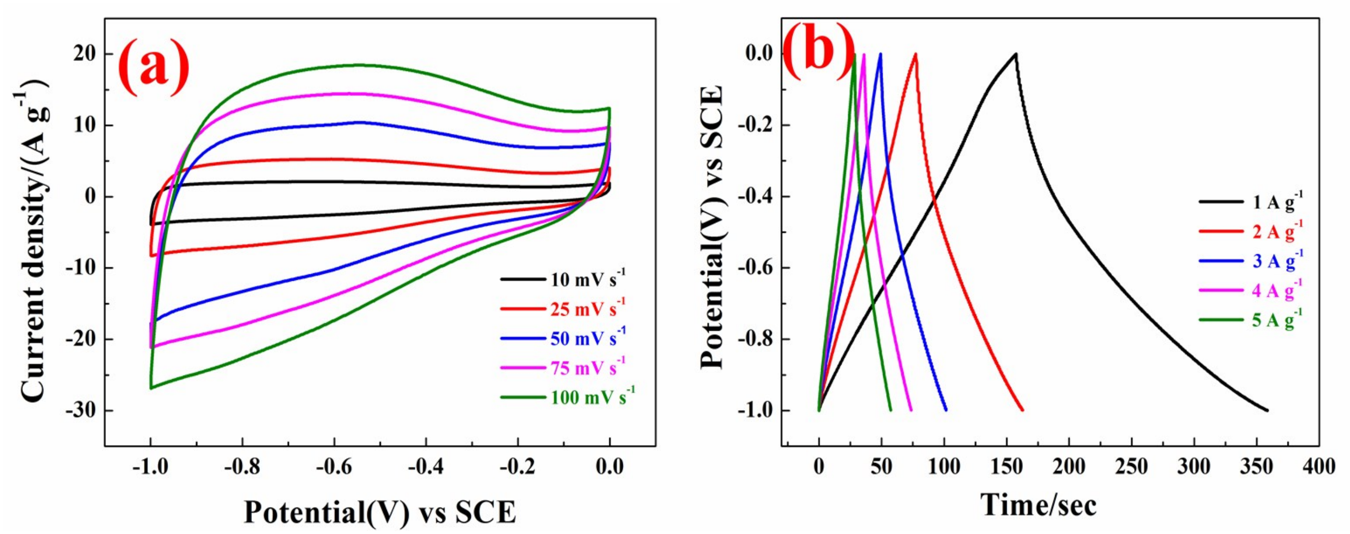


Fig. S8. (a) CV curves of active carbon (AC) at the scan rate between 10 and 100 mV s^{-1}; (b) GCD curves of active carbon (AC) at the current densities between 1 and 5 A g^{-1}.

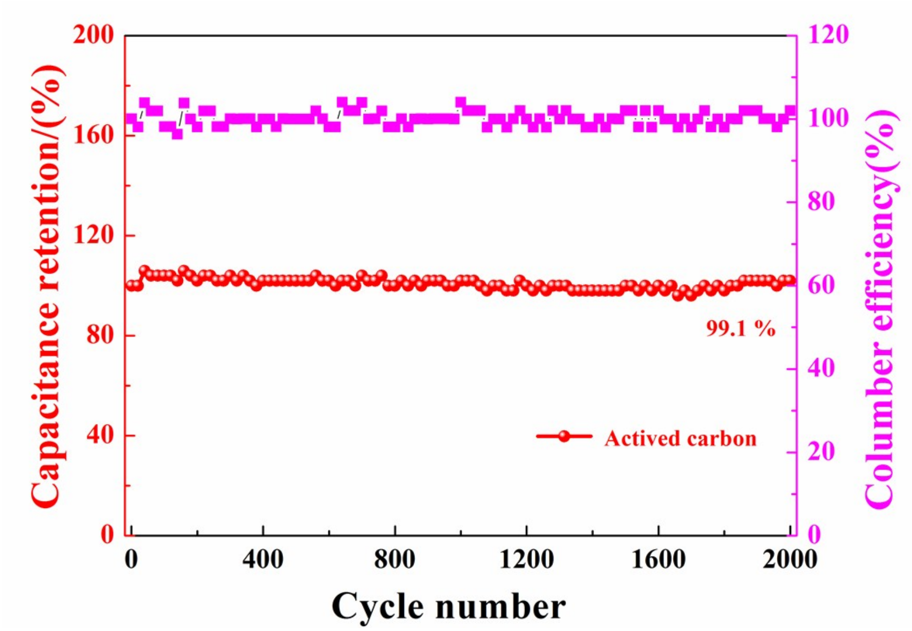


Fig. S9. the cycling stability at current densities of 3 A g^{-1} for activated carbon.

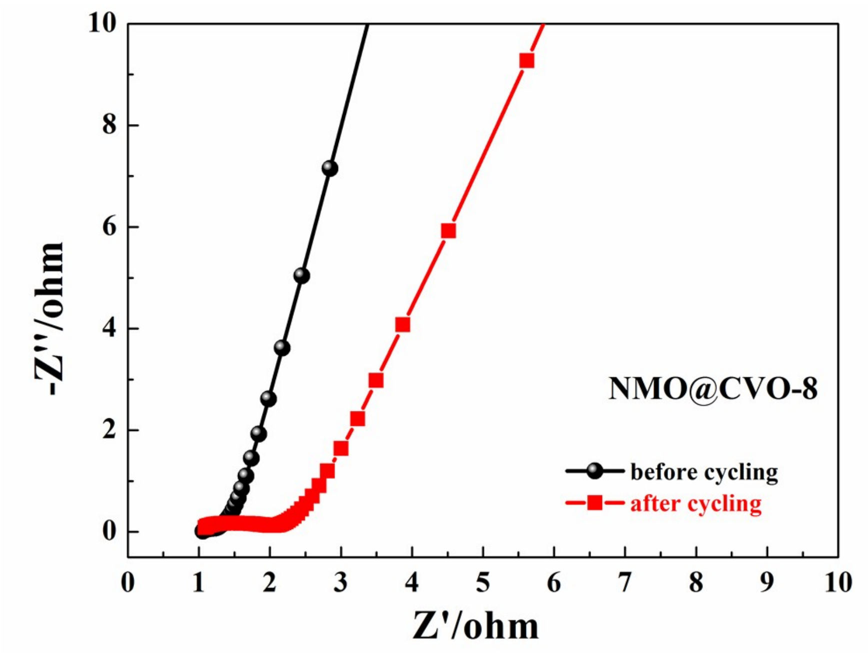


Fig. S10. EIS spectra of before and after cycling of the NMO@CVO-8.

Table. S1. Specific capacitance and cycling performance of the $NiMoO_4@Co_3V_2O_8$ electrode compared with the $NiMoO_4$-based or $Co_3V_2O_8$-based electrodes previously reported in literatures.

Electrode material	Electrolyte	Specific capacitance	Cycling performance	Ref.
$MoO_3/NiMoO_4$ core/shell nanobelts	3 M KOH	630 F g^{-1} (1 A g^{-1})	71% (10,000 cycles)	S1
$NiMoO_4$ nanofibers	6 M KOH	335 C g^{-1} (1 A g^{-1})	72% (3000 cycles)	S2
$NiMoO_4$-PANI core-shell nanocomposite	3 M KOH	1214 F g^{-1} (1 A g^{-1})	80.7% (2000 cycles)	S3
$NiMoO_4$ nanostructures	2 M KOH	341 F g^{-1} (1 A g^{-1})	57% (3000 cycles)	S4
$C@NiMoO_4$	2 M NaOH	268.8 F g^{-1} (1 A g^{-1})	88.4% (2000 cycles)	S5
$NiCo_2O_4@NiMoO_4$ nanofilm core/shell arrays	6 M KOH	3.58 F cm^{-2} (5 mA cm^{-2})	87% (5000 cycles)	S6
$Co_3V_2O_8$ thin nanoplates	3 M KOH	516 F g^{-1} (0.5 A g^{-1})	89% (2000 cycles)	S7
$Co_3V_2O_8$ nanoparticles	6 M KOH	430 F g^{-1} (1 A g^{-1})	92.2% (3000 cycles)	S8
$NiMoO_4@Co_3V_2O_8$ hybrid nanorod nanosphere clusters	**2 M KOH**	**357 C g^{-1} (1 A g^{-1})**	**89.7% (5000 cycles)**	**This work**

Refences:

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