Supplementary Information

Urchin-like $NiCo_2O_4$ hollow microspheres with oxygen vacancies synthesized by self-template for supercapacitors

Zhongwei Luo[a], Dong Shu [a,b,c], Fenyun Yi [a,b,c], Jingzhou Ling [a], Mengyi Wang [a], Chen Huang [a] , Aimei Gao *[a,b,c]

[a.] School of Chemistry, South China Normal University, Guangzhou, 510006, PR China

[b.] Experimental Teaching Demonstration Center of New Energy Materials and Devices, Guangzhou, 510006, PR China

[c.] Engineering Research Center of Materials and Technology for Electrochemical Energy Storage (Ministry of Education)

* Corresponding author E-mail: gaoam@scnu.edu.cn.

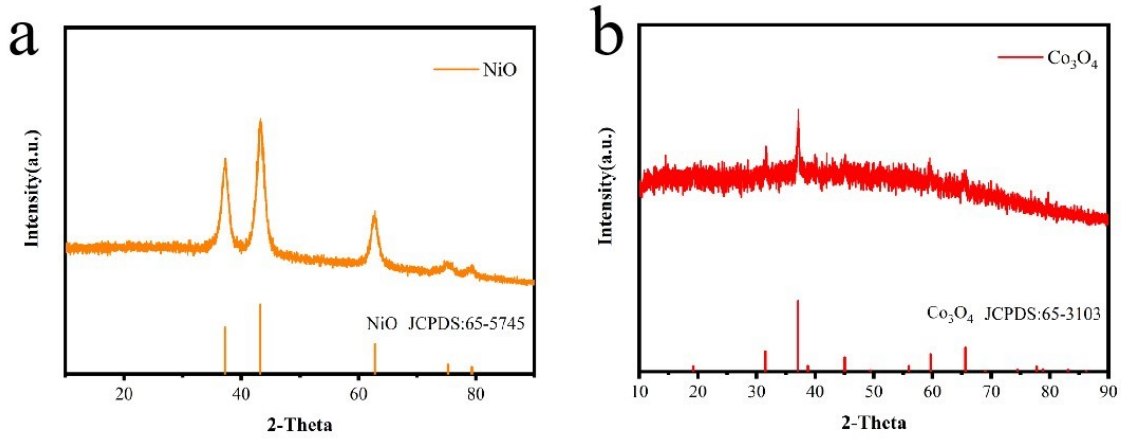

Figure S1. XRD curves of NiO (a) and Co_3O_4 (b).

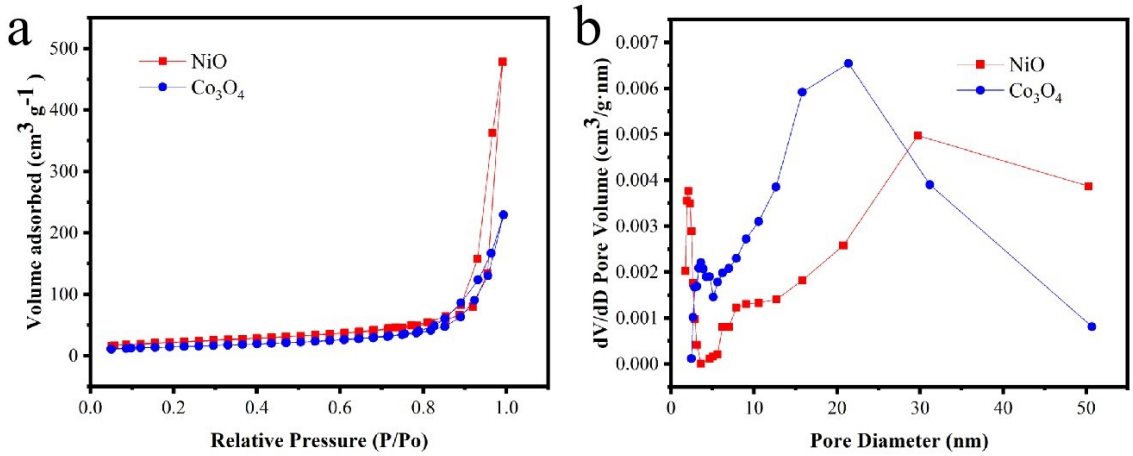

Figure S2. (a) N_2 adsorption /desorption curves and (b) pore size distribution curves of NiO and Co_3O_4.

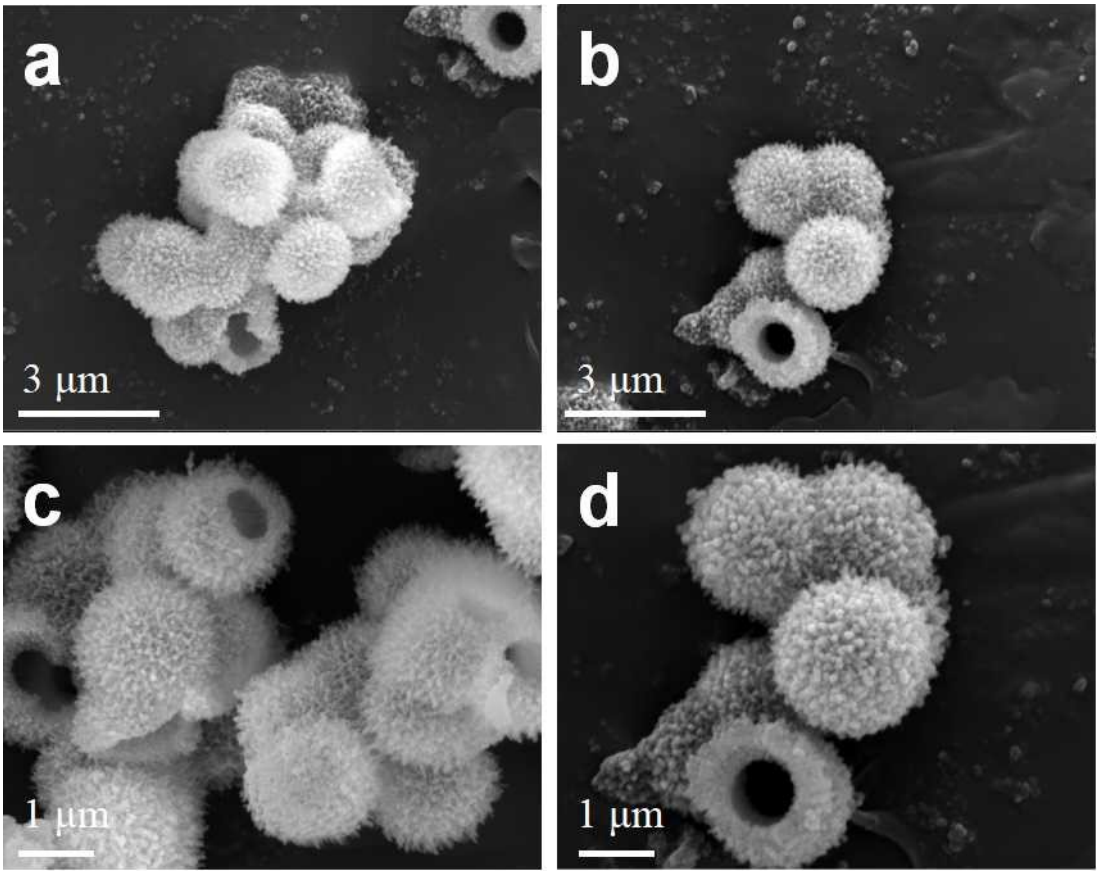

Figure S3. SEM image of NiO (a,c) and Co_3O_4 (b,d).

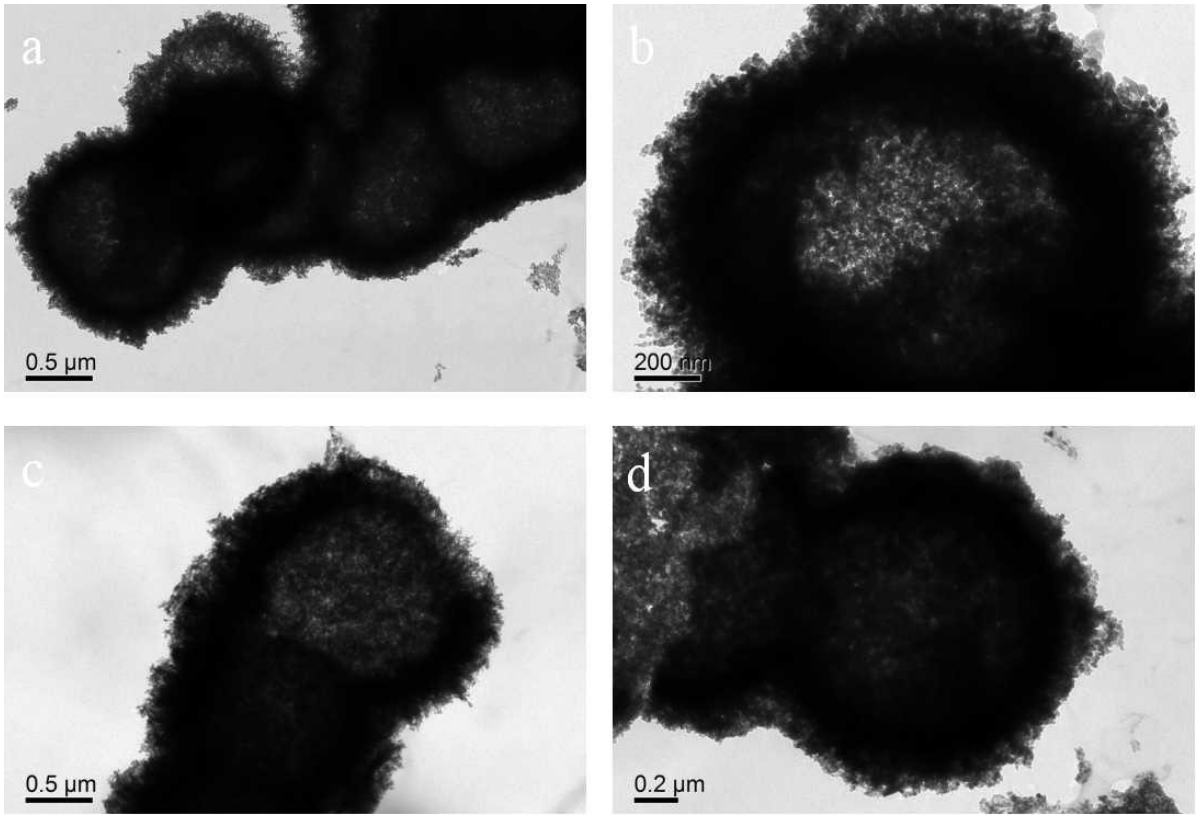

Figure S4. TEM image of NiO (a-b) and Co_3O_4 (c-d).

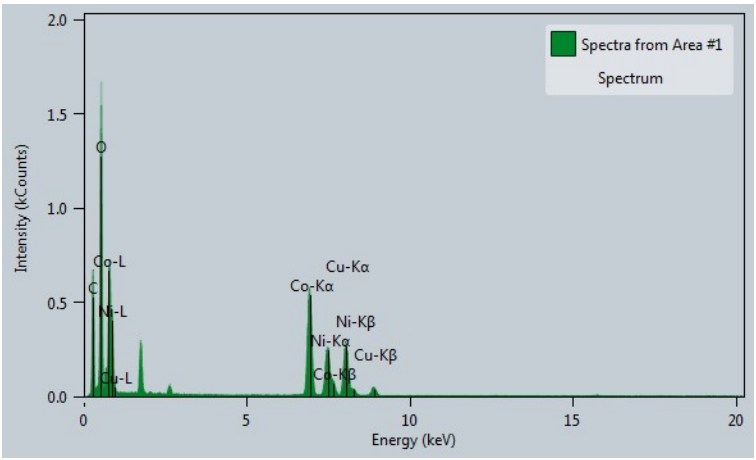

Figure S5. Energy dispersive X-Ray (EDX) spectrum of H-$NiCo_2O_4$.

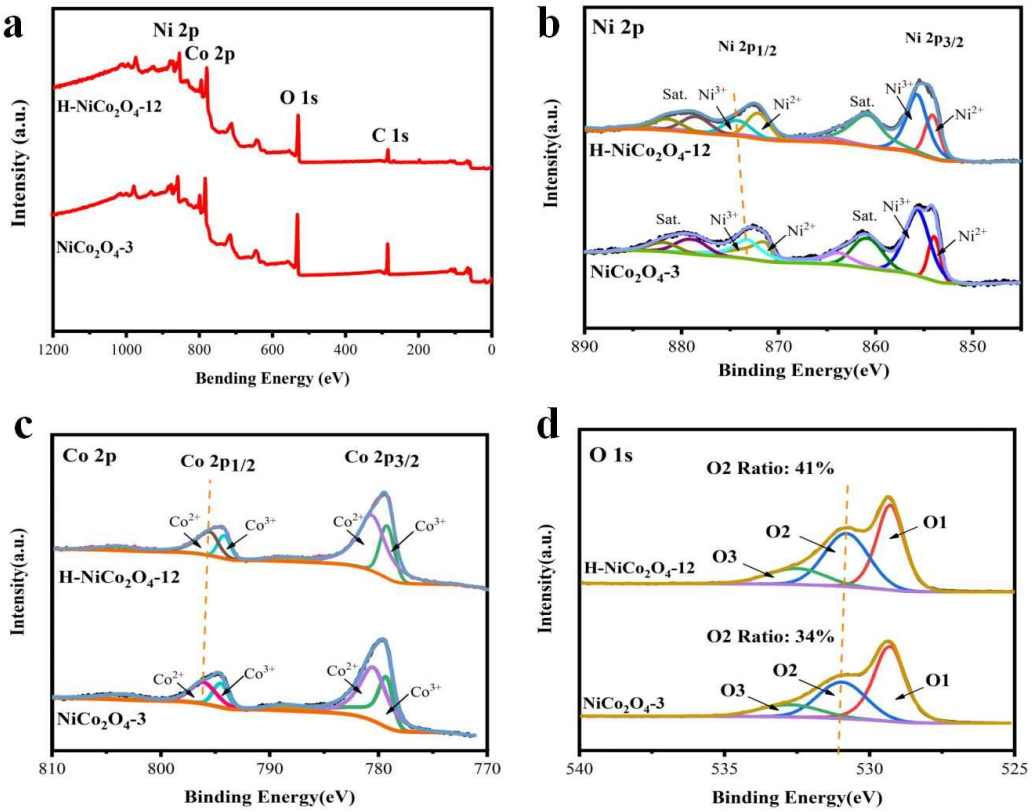

Figure S6. XPS full spectrum (a), high-resolution Ni 2p (b), Co 2p (c) and O 1s (d) of H-$NiCo_2O_4$-12 and $NiCo_2O_4$-3.

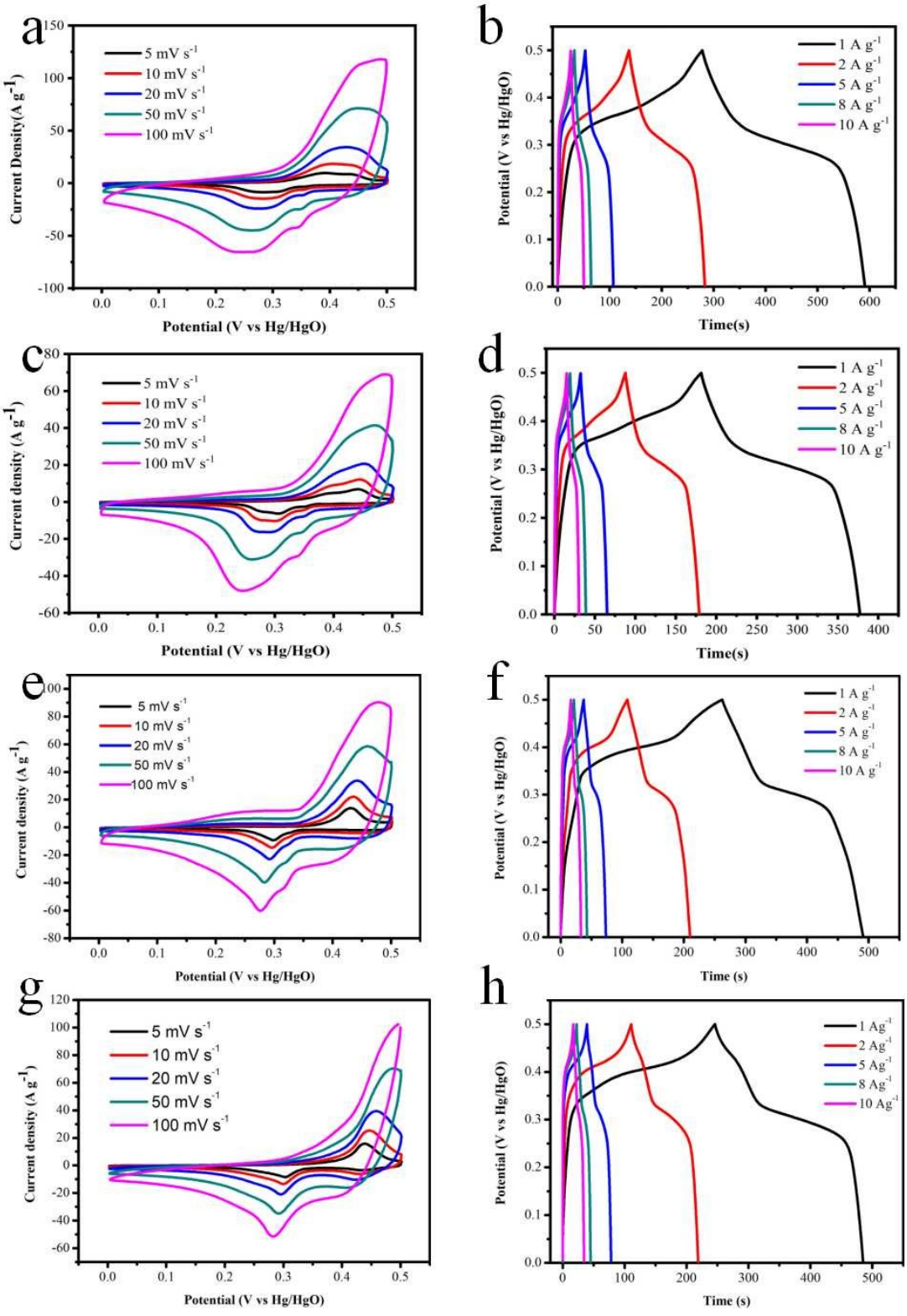

Figure S7. CV curves at various scan rates and GCD curves under different current densities of $NiCo_2O_4$-3 (a, b), $NiCo_2O_4$-1(c, d), NiO (e, f) and Co_3O_4 (g, h), respectively.

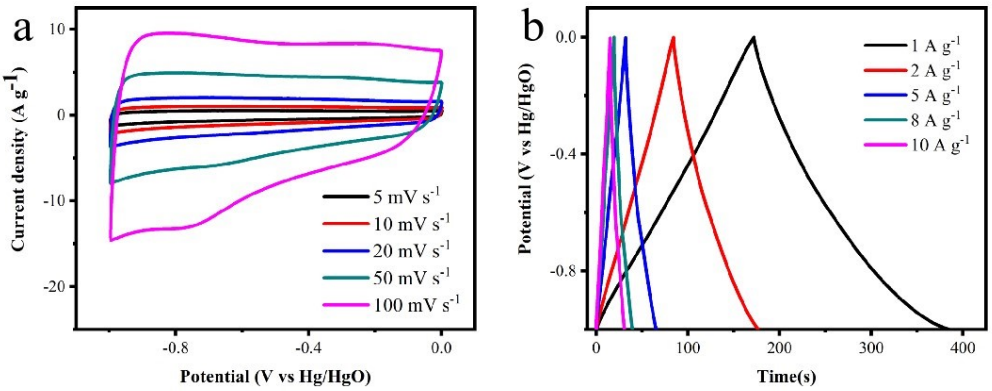

Figure S8. (a) CV curves at various scan rates and (b) GCD curves under different current densities of activated carbon.

Table S1 Comparison of specific capacitance between H-$NiCo_2O_4$ and reported $NiCo_2O_4$-based electrodes.

Sample	Specific capacitance	Rate Capability	Cycle Stability	Ref.
$NiCo_2O_4$ nanoflowers	702 F g^{-1} (5mV s^{-1})	--------	94.2% (5000 C)	[1]
YS-$NiCo_2O_4$	835.7 F g^{-1} (0.5 A g^{-1})	64 % (1 to 20 A g^{-1})	70.5 % (10000 C)	[2]
NiCo2O4@ CNFs	540 F g^{-1} (1A g^{-1})	46 % (1 to 7 A g^{-1})	93.1 % (6000 C)	[3]
PNCO@FSSM	530 F g^{-1} (6 mA cm^{-2})	----------	90.5 % (3000 C)	[4]
3D rGN/$NiCo_2O_4$	708.36 F g^{-1} (1A g^{-1})	82% (1 to 16 A g^{-1})	94.3 % (6000 C)	[5]
honeycomb-like $NiCo_2O_4$@NF	646.6 F g^{-1} (1A g^{-1})	68% (1 to 9 A g^{-1})	96.5% (3000 C)	[6]
$NiCo_2O_4$	725.7 F g^{-1} (1A g^{-1})	48.5% (1 to 10 A g^{-1})	70 % (5000 C)	[7]
H-$NiCo_2O_4$	862 F g^{-1} (1A g^{-1})	74.2% （1 to 10 A g^{-1})	80% (5000 C)	This work

References

1. R. B. Waghmode, N. C. Maile, D. S. Lee and A. P. Torane, *Electrochim. Acta*, 2020, **350**, 136413.
2. L. Wang, X. Y. Jiao, P. Liu, Y. Ouyang, X. F. Xia, W. Lei and Q. L. Hao, *Appl. Surf. Sci.*, 2018, **427**, 174-181.
3. M. H. El-Shafei, A. G. El-Deen and A. Abd El-Moneim, *J Mater Sci: Mater Electron*, 2021, **32**, 15882–15897.

4. G.P. Kamble, A.S. Rasal, S.A. Mane, R.A. Chavan, J.-Y. Chang, Y.-C. Ling, S.S. Kolekar and A.V. Ghule, *RSC Adv.*, 2021, **11**, 3666-3672.
5. Y. Zhou, H. J. Liao, J. Li, H. X. Wang and Y. Wang, *Appl. Surf. Sci.*, 2021, **534**, 147598.
6. D. R. Kumar, K. R. Prakasha, A. S. Prakash and J. J. Shim, *J. Alloys Compd.*, 2020, **836**, 155370.
7. Q. Y. Wang, J. Y. Zhao, C. Zhang, X. Luo, J. Shao, M. Zhong, Z. H. Ye, P. D. Feng, X. L. Liu, K. Li and W. W. Zhao, *J. Alloys Compd.*, 2021, **852**, 156613.