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Electronic Supplementary Information (ESI)

Facile template-free synthesis of ultralayered mesoporous nickel cobaltite nanowires towards high-performance electrochemical capacitors

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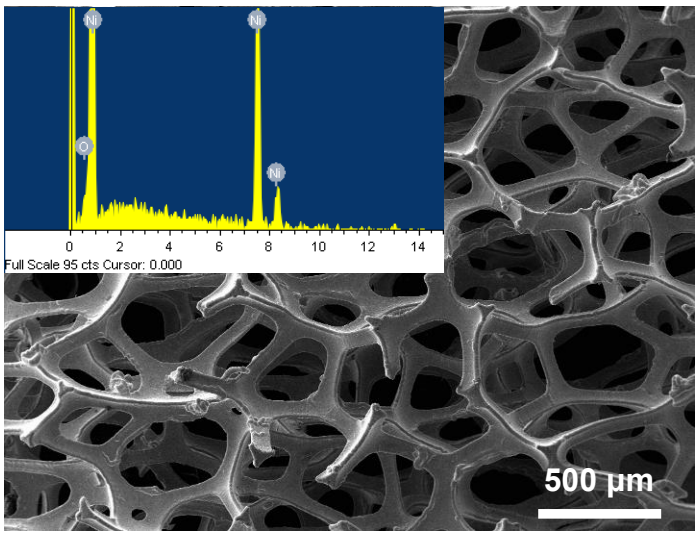

Fig. S1 FESEM images and EDAX (the inset) of the pretreated nickel foam

As seen in the Fig. S1, a three dimensional (3 D) grid structure and hierarchical porosity can be seen for the Ni foam itself. Moreover, the high purity of the Ni foam can be seen from the EDAX data (the inset in Fig. S1).

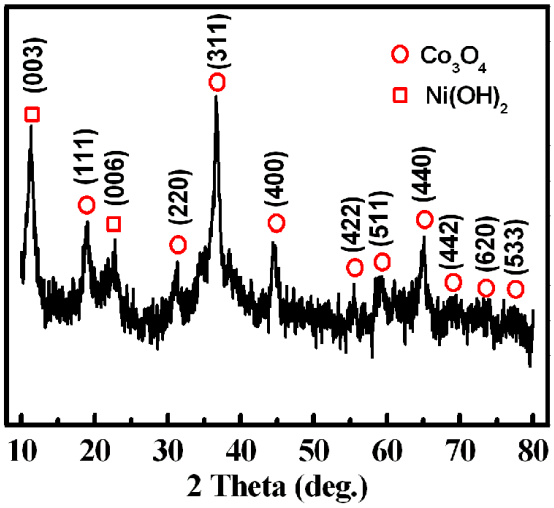

Fig. S2 XRD pattern of the uncalcinated precursor of the $NiCo_2O_4$ NWs

Of note, Co^{2+} and Ni^{2+} ions have similar coordination capability with other ions. Here, the added NH_4NO_3 makes the bivalent Co^{2+} and Ni^{2+} ions fully coordinated with NH_4^+ to form $M(NH_3)_x^{2+}$ ions,[1] which will result in a relatively constant ratio of Co^{2+} to Ni^{2+} ions. [1-4] Additionally, Co^{2+} and Ni^{2+} ions have similar affinity towards OH^- ions according to their solubility constants. [1-4] The difference between Ni^{2+} and Co^{2+} ions may be reduced by forming complex with NH_4^+, which leads to a similar nucleation and grown rate of $Co(OH)_2$ and $Ni(OH)_2$. Then during the following stirring and refluxing process, the Co_3O_4 comes from the solid-state reaction between the formed $Co(OH)_2$ and the dissolved oxygen in the solution following the reactions as reported before [5, 6]:

$$Co(OH)_2(s)+\frac{1}{2}O_2(aq)=Co_3O_4(s)+3H_2O(l)$$

As seen from the Fig. S2, clearly, the unclacinated precursor can be well indexed as a mixed phase including the $Ni(OH)_2$ (JCPDS card no. 38-0715) and cubic Co_3O_4 (JCPDS card no. 43-1007).

[1] L.Y. Yuan, X.H. Lu, X. Xiao, T. Zhai, J.J. Dai, F.C. Zhang, B. Hu, X. Wang, L. Gong, J. Chen, C.G. Hu, Y.X. Tong, J. Zhou, Z.L. Wang, *ACS Nano*, **2012**, 6, 656-661.

[2] X.H. Lu, D.Z. Zheng, T. Zhai, Z.Q. Liu, Y.Y. Huang, S.L. Xie, Y.X. Tong, *Energy Environ. Sci.*, **2011**, 4, 2915-2912.

[3] D. Yuan, T.X. Zhou, S.L. Zhou, S.S. Mo, N.N. Xia, *Electrochem. Commun.*, **2011**, 13, 242-246.

[4] X.H. Lu, X. Huang, S.L. Xie, T. Zhai, C.S. Wang, P. Zhang, M.H. Yu, W. Li, C.L. Liang, Y.X. Tong, *J. Mater. Chem.*, **2012**, DOI:10.1039/C2JM30927K.

[5] Y.G. Li, B. Tan, Y.Y. Wu, Nano Lett. 2008, 8, 265-270.

[6] Y.G. Li, B. Tan, Y.Y. W, J. Am. Chem. Soc. 2006, 128, 14258-14259.

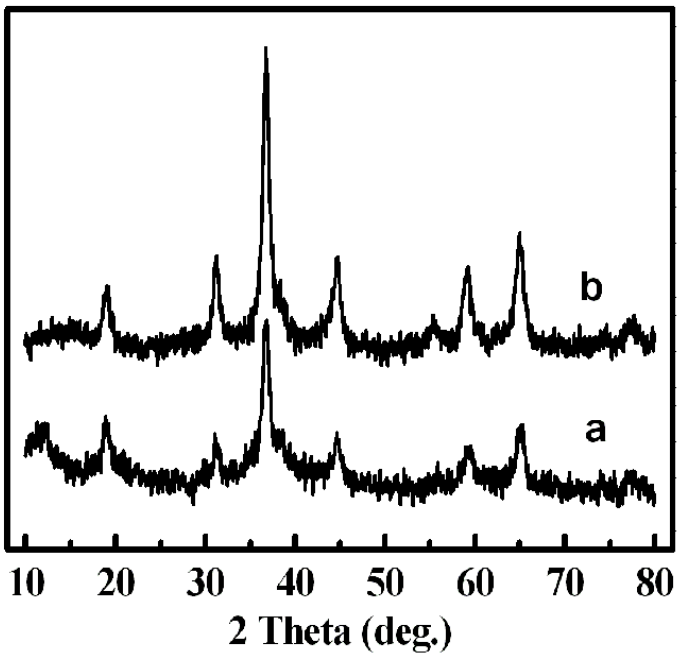

Fig. S3 XRD patterns for the precursor of the $NiCo_2O_4$ NWs calcinated at different temperatures. (a) 200 ºC; (b) 400 ºC.

As seen from the Fig. S3, after calcinated at 200 ºC, the obtained sample still presents typical diffraction peaks of $Ni(OH)_2$, with the comparison with the Fig. S2. And when the temperature increases up to 300 and 400 ºC, the diffraction peak of $Ni(OH)_2$ wholly disappears and the pure phase of $NiCo_2O_4$ can be found.

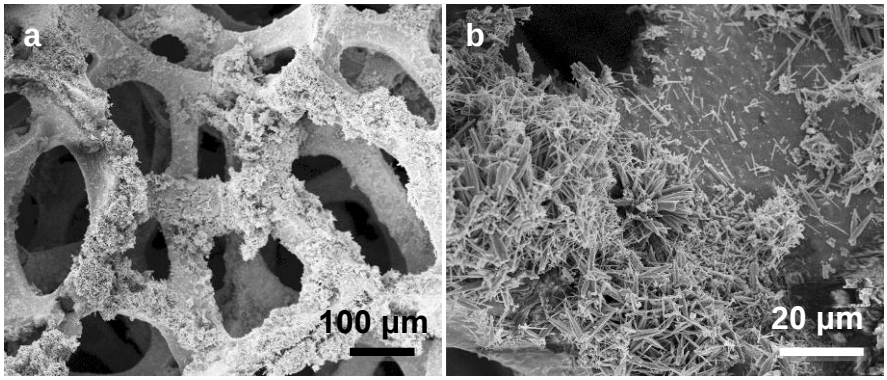

Fig. S4 FESEM images of the $NiCo_2O_4$ NWs/nickel foam after ultrasonication.

After ultrasonication for 1h in ethanol, the $NiCo_2O_4$ NWs/nickel foam still demonstrates black color and the ethanol solution turns out to dark black. As seen from Fig. S4, some $NiCo_2O_4$ NWs still can be found randomly dispersed on the surface of the Ni foam after ultrasonication, demonstrating a disordered NWs structure. Therefore, it is easy to conclude that the adherence of $NiCo_2O_4$ NWs to the Ni foam is relatively strong.

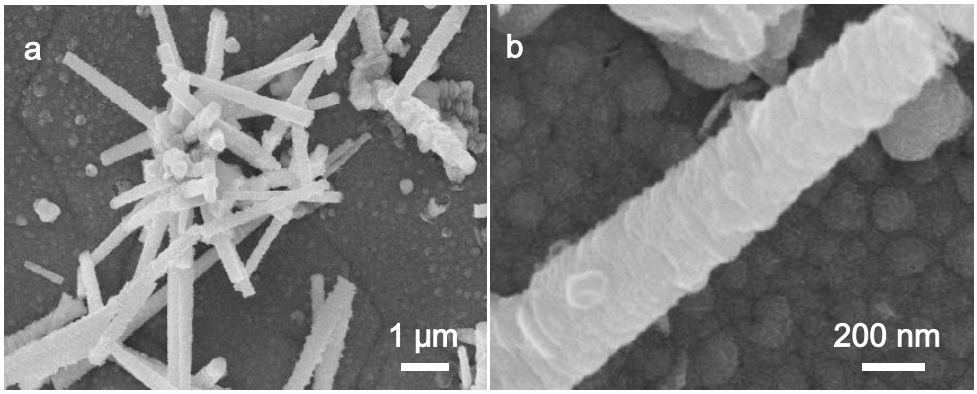

Fig. S5 FESEM images of the precursor for the $NiCo_2O_4$ NWs

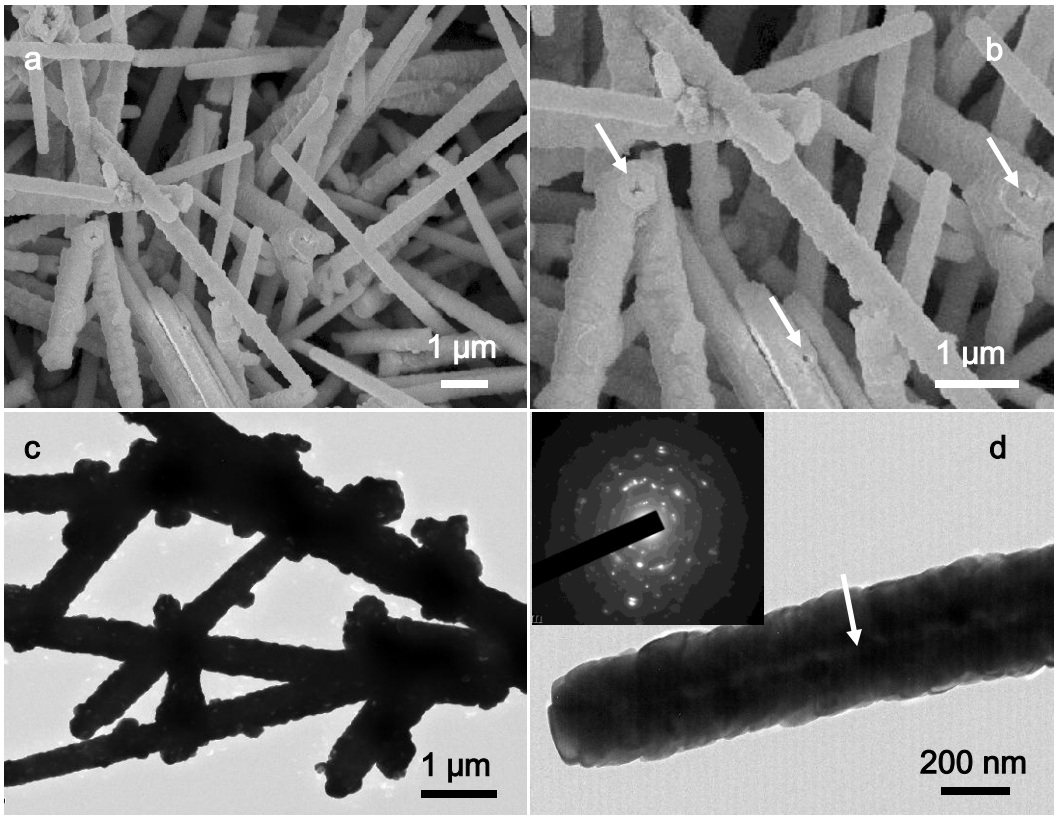

Fig. S6 FESEM (a, b), TEM (c, d) images and SAED pattern (the inset in d) of the Co_3O_4 NWs. The white arrays indicate their hollow nature

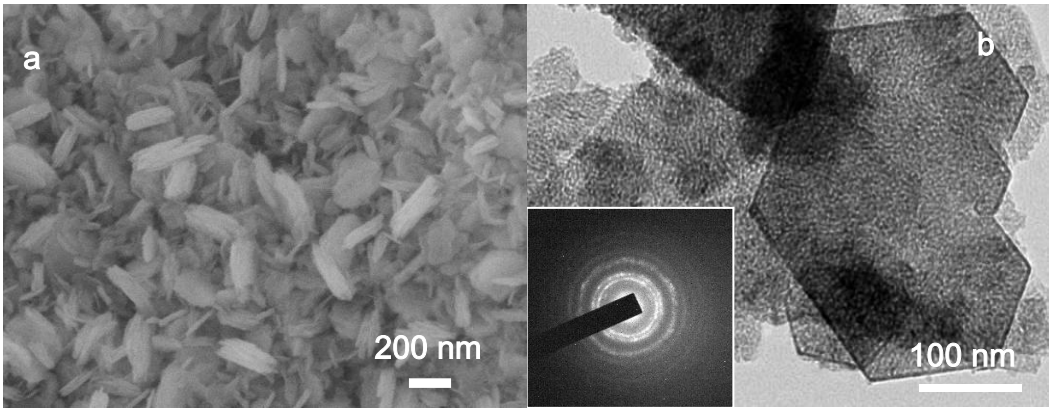

Fig. S7 (a) SEM, (b) TEM images and SAED pattern (the inset in b) of the NiO nanosheets

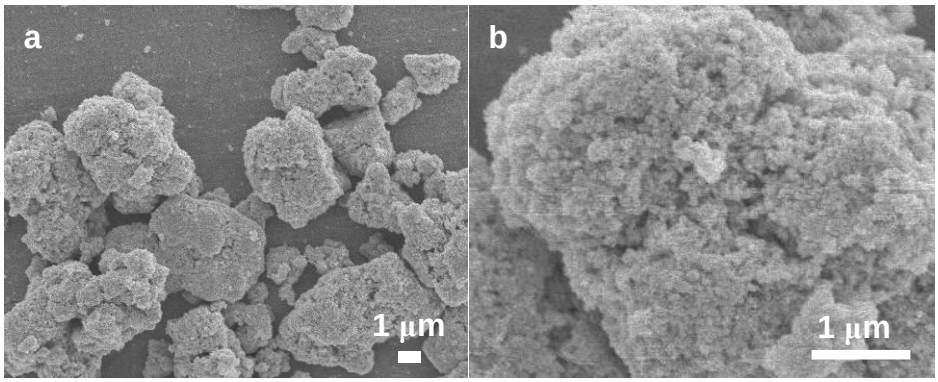

Fig. S8 FESEM images of the $NiCo_2O_4$ obtained from the bottom of the three-neck bottle

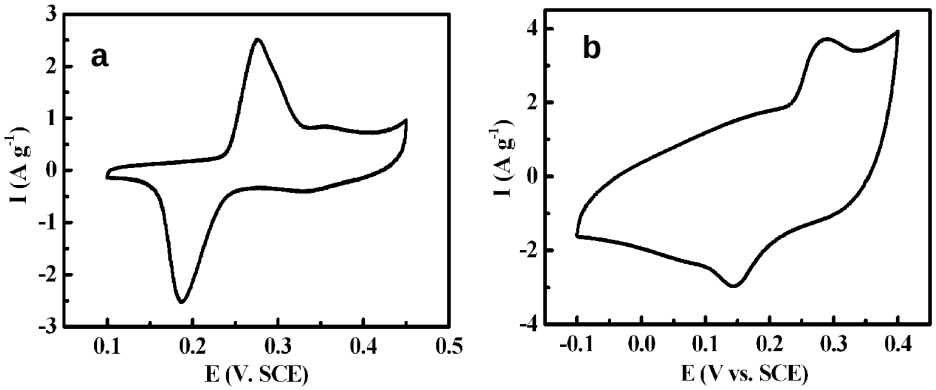

Fig. S9 CV curves (10 mV s^{-1}) of the Co_3O_4 NWs (a) and NiO nanosheets (b), respectively.

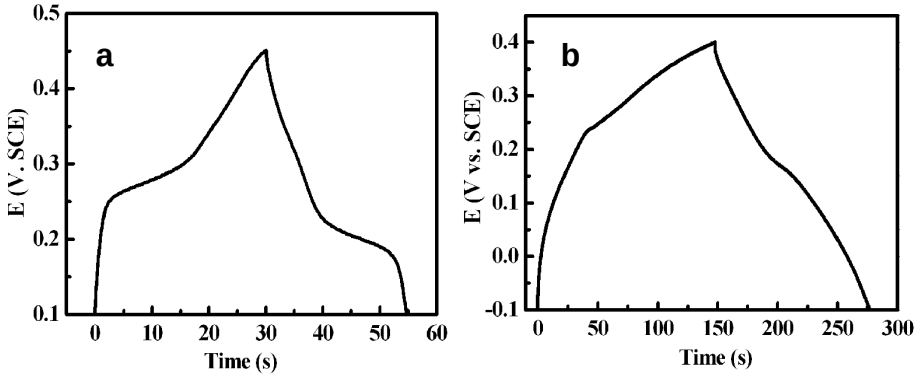

Fig. S10 CP plots (1 A g^{-1}) of the Co_3O_4 NWs (a) and NiO nanosheets (b), respectively.