

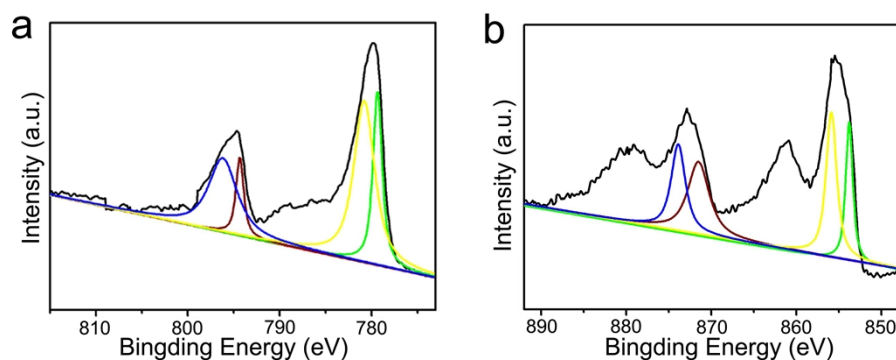
## Three-Dimensional Networked NiCo<sub>2</sub>O<sub>4</sub>/MnO<sub>2</sub> Branched Nanowires Heterostructure Arrays on Nickel Foam with Enhanced Supercapacitor Performance

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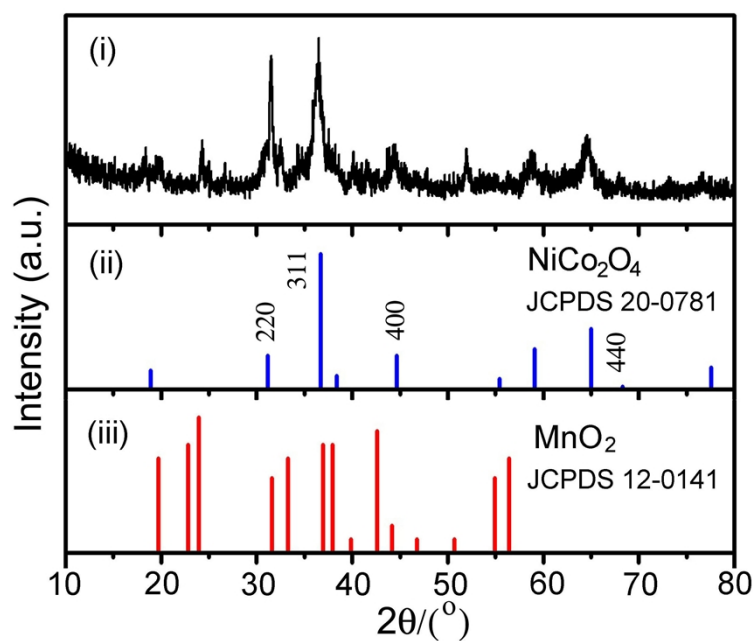
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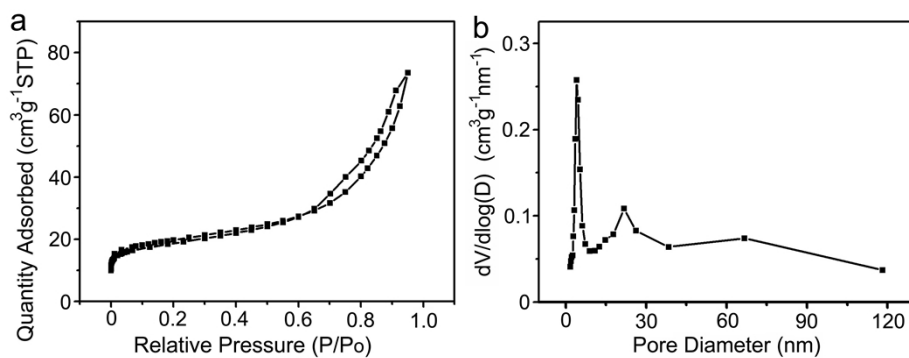
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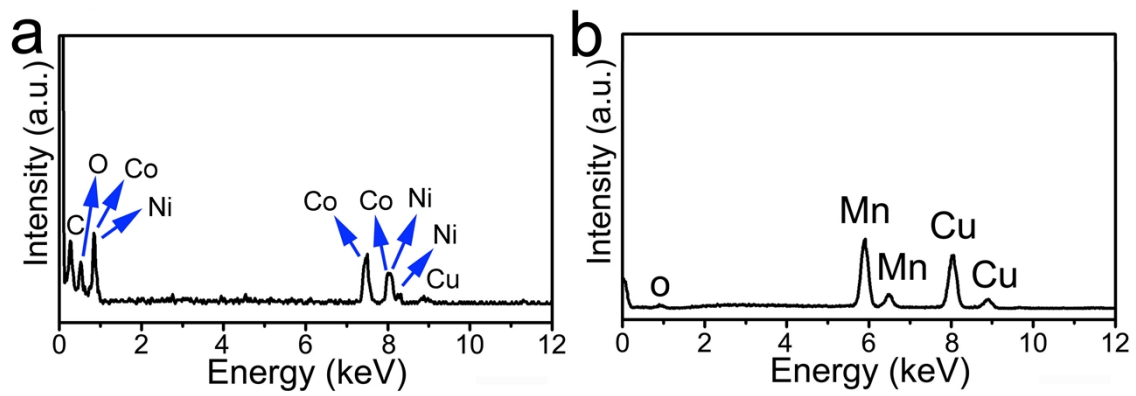
**Fig. S1** (a) Co 2p XPS spectrum and (b) Ni 2p XPS spectrum.



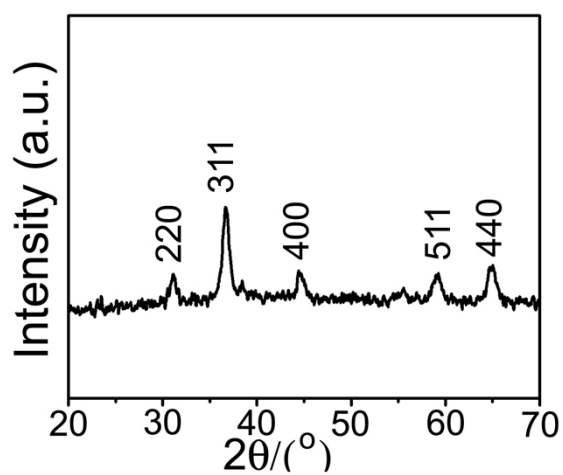
**Fig. S2** XRD patterns of the as-synthesized networked NiCo<sub>2</sub>O<sub>4</sub>/MnO<sub>2</sub> BNH after calcination (i), the NiCo<sub>2</sub>O<sub>4</sub> powders (ii) and MnO<sub>2</sub> powders (iii) from JCPDS card (NiCo<sub>2</sub>O<sub>4</sub>: No. 20-0781 and No. 12-0141), respectively.



**Fig. S3** (a) Nitrogen adsorption-desorption isotherms of NiCo<sub>2</sub>O<sub>4</sub>/MnO<sub>2</sub> scratched from Ni substrate. (b) The pore size distribution curve obtained from the desorption data.



**Fig. S4** Typical EDX spectrum taken from a selected area of the  $\text{NiCo}_2\text{O}_4$  core nanowire and  $\text{MnO}_2$  branched nanowires.



**Fig. S5** XRD patterns of the networked  $\text{NiCo}_2\text{O}_4/\text{MnO}_2$  BNH arrays after 1 h of growth on Ni foam after post annealing process.

**Table S1.** A comparison of different growth techniques for branched nanowires.

Methods	Typical materials	Advantages	Disadvantages	References
Solution growth on pre-formed nanowires	ZnO/CuO, SnO <sub>2</sub> /ZnO, Si/ZnO <sub>2</sub> , SnO <sub>2</sub> /Fe <sub>2</sub> O <sub>3</sub> , Si/TiO <sub>2</sub>	High yield, large-scale, low cost	Multiple steps, poor assembly	1-3
Sequential catalyst assisted growth	In <sub>2</sub> O <sub>3</sub> /SnO <sub>2</sub>	High crystalline quantity, good control	Metal catalyst needed, high temperature	4,5
One-step self-catalysed growth	ZnO/In <sub>2</sub> O <sub>3</sub>	Metal catalyst-free, high crystalline quality	High temperature CVD	6,7
One-step hydrothermal reaction	NiCo <sub>2</sub> O <sub>4</sub> /MnO <sub>2</sub>	Simplicity, large-scale, low cost, uniformity	Low crystalline quality	This work

1 C. W. Cheng, B. Liu, H. Y. Yang, W. W. Zhou, L. Sun, R. Chen, S. F. Yu, J. X. Zhang, H. Gong, H. D. Sun and H. J. Fan, *ACS Nano*, 2009, **3**, 3069.

2 W. Zhou, C. Cheng, J. P. Liu, Y. Y. Tay, J. Jiang, X. T. Jia, J. X. Zhang, H. Gong, H. H. Hng, T. Yu and H. J. Fan, *Adv. Funct. Mater.*, 2011, **21**, 2439.

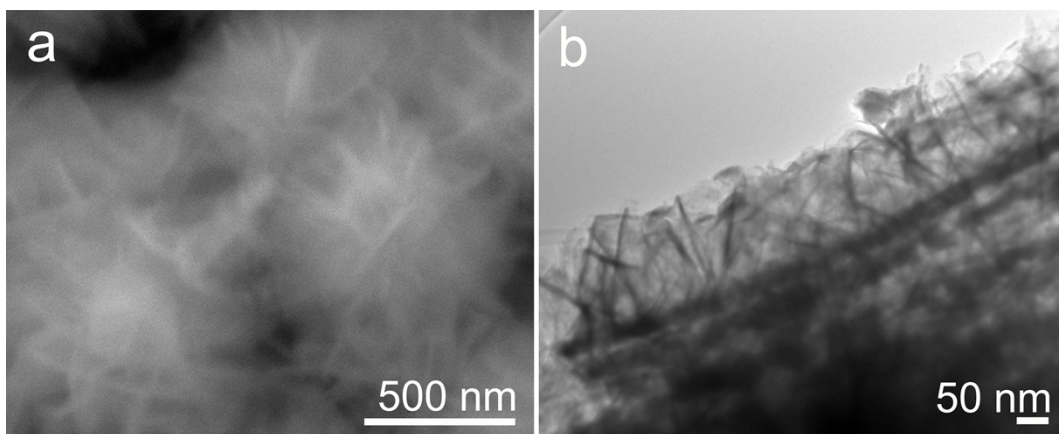
3 A. Kargar, Y. Jing, S. J. Kim, C. T. Riley, X. Q. Pan and D. L. Wang, *ACS Nano*, 2013, **7**, 11112.

4 D. Wang, F. Qian, C. Yang, Z. H. Zhong and C. M. Lieber, *Nano Lett.*, 2004, **4**, 871.

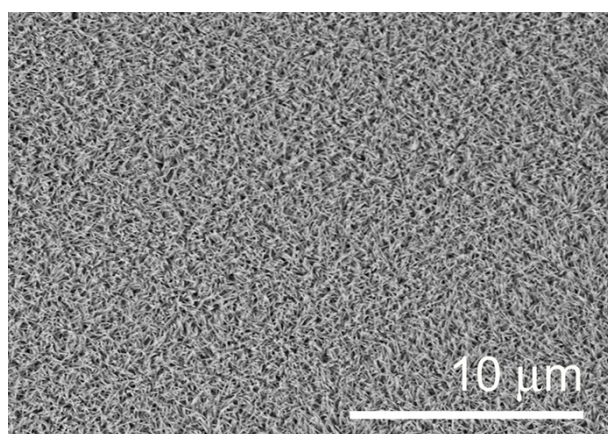
5 C. Yan, X. Li, K. Zhou, A. Pan, P. Werner, S. L. Mensah, A. T. Vogel and V. Schmidt, *Nano Lett.*, 2012, **12**, 1799.

6 J. Y. Lao, J. G. Wen and Z. F. Ren, *Nano Lett.*, 2002, **2**, 1287.

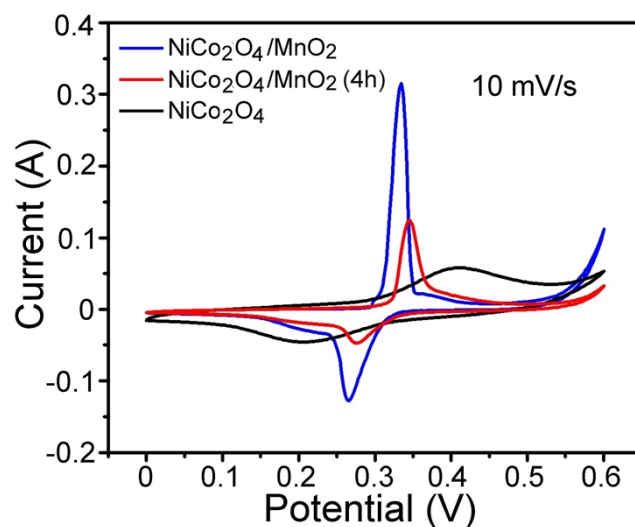
7 F. Sauvage, F. Di Fonzo, A. L. Bassi, C. S. Casari, V. Russo, G. Divitini, C. Ducati, C. E. Bottani, P. Comte and M. Graetzel, *Nano Lett.*, 2010, **10**, 2562.



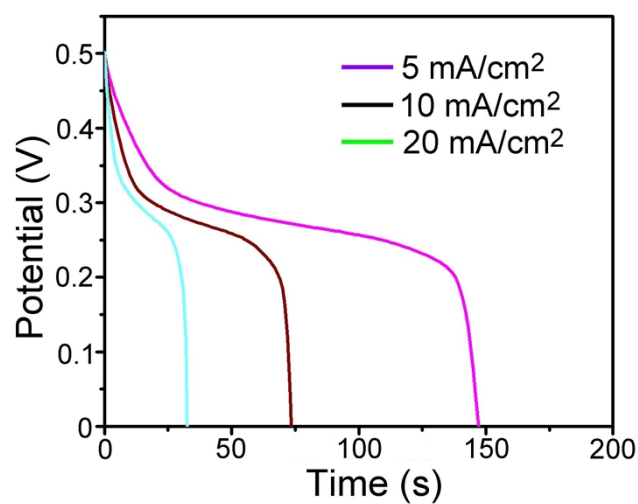
**Fig. S6** SEM and TEM images of the NiCo<sub>2</sub>O<sub>4</sub>/MnO<sub>2</sub> CSH arrays.



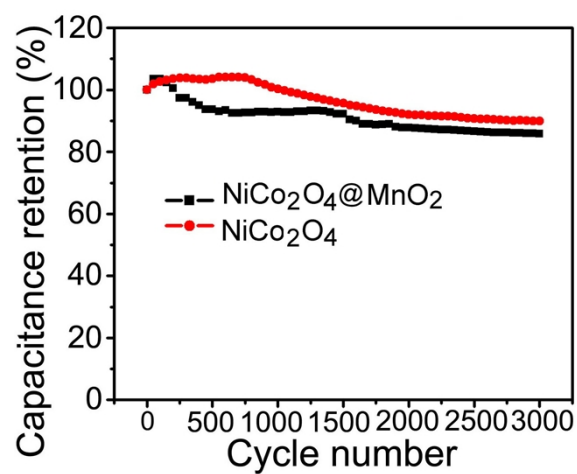
**Fig. S7** SEM image of the NiCo<sub>2</sub>O<sub>4</sub> nanowires arrays.



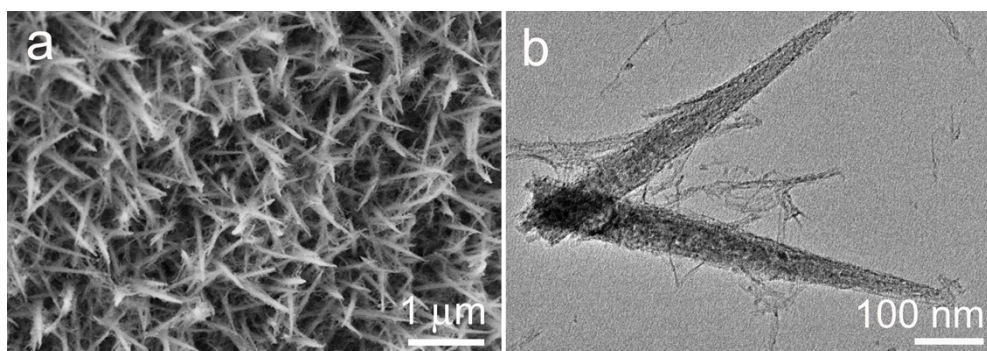
**Fig. S8** Comparison of the networked  $\text{NiCo}_2\text{O}_4/\text{MnO}_2$  BNH electrode, networked  $\text{NiCo}_2\text{O}_4/\text{MnO}_2$  BNH electrode after 4 h of growth on Ni foam and  $\text{NiCo}_2\text{O}_4$  nanowires electrode at the same scan rate of  $10 \text{ mV s}^{-1}$ .



**Fig. S9** Discharge curves at different scan rates recorded from electrodes consisting of networked  $\text{NiCo}_2\text{O}_4/\text{MnO}_2$  BNH electrode.



**Fig. S10** Cycling performances of NiCo<sub>2</sub>O<sub>4</sub> nanowires arrays and NiCo<sub>2</sub>O<sub>4</sub>@MnO<sub>2</sub> CSH electrodes during 3000 cycles at constant current densities of 10 mA cm<sup>-2</sup>.



**Fig. S11** (a) SEM and (b) TEM images of the NiCo<sub>2</sub>O<sub>4</sub>/MnO<sub>2</sub> after 3000 cycles at constant current densities of 10 mA cm<sup>-2</sup>.