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

Supporting Information

Seed-assisted smart construction of high mass loading Ni-Co-Mn hydroxide nanoflakes for supercapacitor application

Shaoran Yang, Chun Wu, Junjie Cai, Ying Zhu, Hongti Zhang, Yang Lu, Kaili Zhang*

Department of Mechanical and Biomedical Engineering, City University of Hong Kong, 83 Tat Chee Avenue, Hong Kong

* Corresponding author, E-mail address: kaizhang@cityu.edu.hk

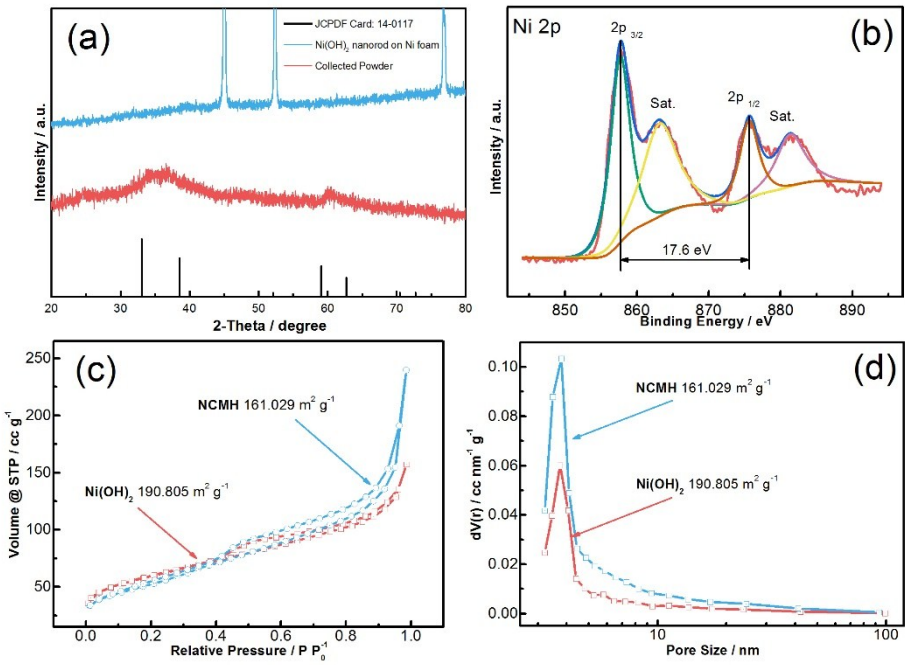

Figure S1 (a) XRD patterns of $Ni(OH)_2$ nanorod seeds, Ni foam supported sample and powder collected form the CBD solution and (b) XPS spectrum for Ni 2p of $Ni(OH)_2$ nanorod seeds (c) N_2 gas adsorption–desorption curves and (d) pore size distribution curves of $Ni(OH)_2$ nanorod arrays and NCMH.

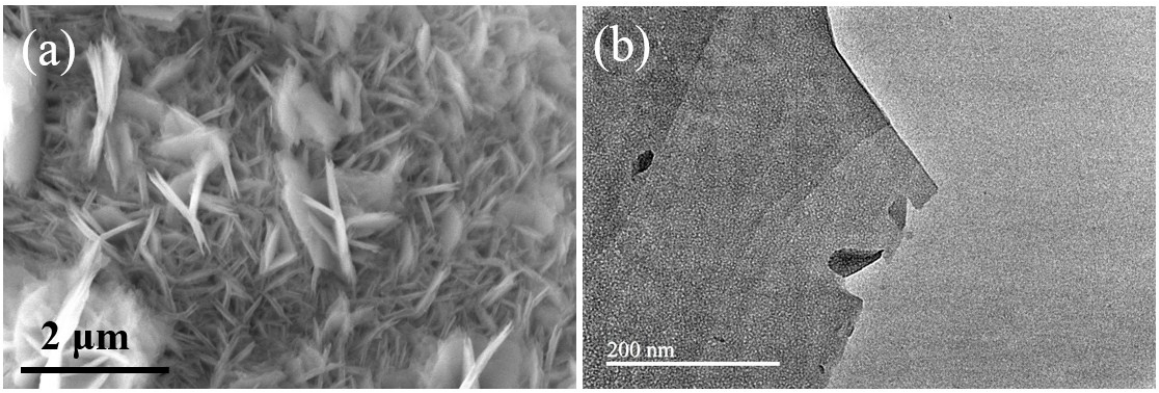

Figure S2 (a) SEM image and (b) TEM image of non-seed-assisted NCMH

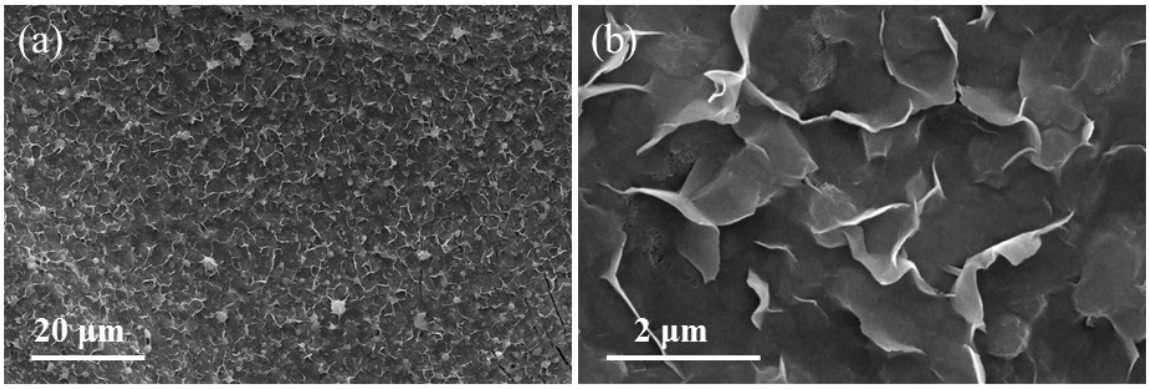

Figure S3 SEM images in different magnifications of Ni supported $Ni(OH)_2$ nanorod arrays reacting with control solution

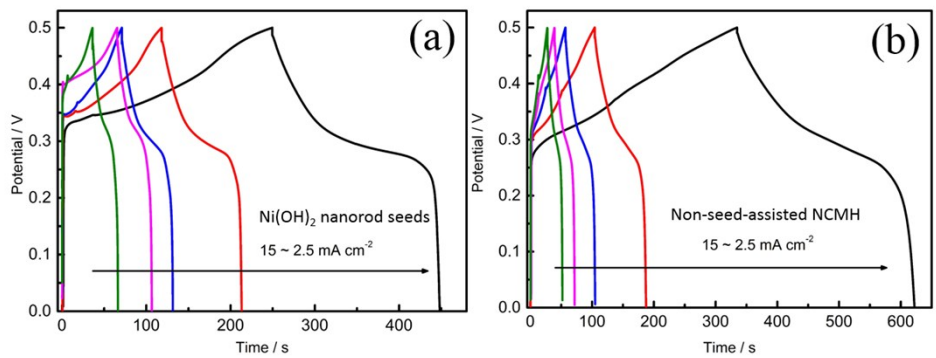

Figure S4 GCD curves of (a) $Ni(OH)_2$ nanorod seeds and (b) non-seed-assisted NCMH in different current densities: (from right to left) 2.5, 5.0, 7.5, 10 and 15 mA cm^{-2}

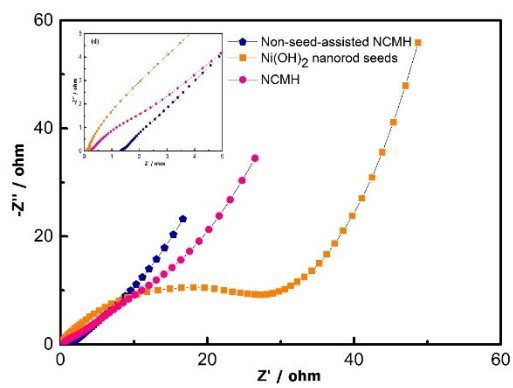

Figure S5 EIS Nyquist plots of NCMH, $Ni(OH)_2$ nanorod arrays seeds and non-seed-assisted NCMH in a frequency range from 0.01 Hz to 100000 Hz. The inset shows the enlarged high frequency region.

In the two-electrode set-up, mass ratio of positive and negative active materials are calculated as follows:

For the negative carbon based material:

$$Q_{-} = C_{-} \times \Delta V \times m_{-}$$

Where C- represents the specific capacitance of electrode (F g^{-1}), ΔV is the potential range, and m- is the weight of the RGO material (g).

For the "battery-type" positive materials:

$$Q_{+} = C'_{+} \times m_{+}$$

Where C'+ represents the specific capacity of electrode (mAh g^{-1}) and m+ is the weight of NCMH (g).

To obtain Q+=Q-, the mass balance will be expressed as following equation:

$$\frac{m_+}{m_-} = \frac{C_- \times \Delta V_-}{C'_+}$$

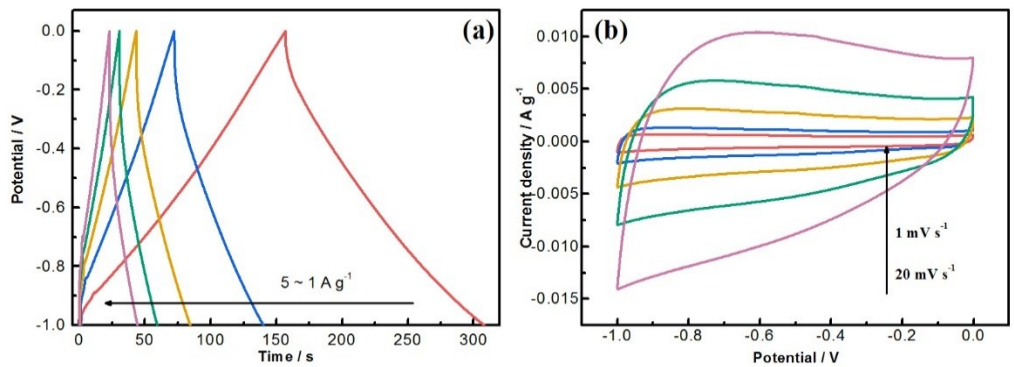

Figure S6 (a) GCD curves in 1, 2, 3, 4, 5 A g^{-1} and (b) CV curves in 1, 2, 5, 10, 20 mV s^{-1} for activated carbon.

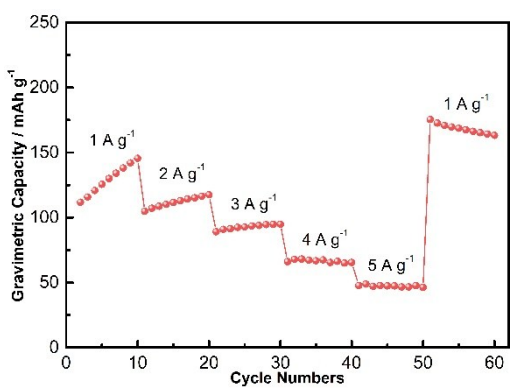

Figure S7 Rate performance of the device.

Table S1 Supercapacitor electrodes materials with Ni/Co/Mn elements in previous studies, the units are converted to "F" for the convenience of comparison.

Sample	Specific Capacitance	Test Condition	Mass Loading
This study	7.51 F cm^{-2} (1445 F g^{-1})	2.5 mA cm^{-2}	5.2 mg cm^{-2}
Ni–Co–Mn hydroxide nanoneedle[1]	520 F g^{-1}	1 mA cm^{-2}	0.6 mg cm^{-2}
Ni–Co–Mn oxide nanoneedle[2]	2023 F g^{-1}	1 mA cm^{-2}	0.5 mg cm^{-2}
Co Mn co-doped NiO nanocrystalline[3]	673 F g^{-1}	0.5 A g^{-1}	0.5 mg cm^{-2}
$Ni(OH)_2$ nanoflake/ZnO nanowire[4]	1830 F g^{-1}	2 A g^{-1}	0.15 mg cm^{-2}
$MnO_2/Ni(OH)_2$ networks[5]	843 F g^{-1}	1 A g^{-1}	1.0 mg cm^{-2}
$Co_3O_4/Co(OH)_2$ nanoflake[6]	0.458 F cm^{-2}	2 mV s^{-1}	2.0 mg cm^{-2}
Co_2MnO_4/rGO[7]	1089.3 F g^{-1}	1 A g^{-1}	1.08 mg cm^{-2}
$NiCo_2O_4$ nanoflakes[8]	3.51 F cm^{-2}	1.8 mA cm^{-2}	1.2 mg cm^{-2}

References

1. G. Xiong, P. He, L. Liu, T. Chen and T. S. Fisher, *J. Mater. Chem. A*, 2015, **3**, 22940-22948.
2. G. Xiong, P. He, L. Liu, T. Chen and T. S. Fisher, *Frontiers in Energy Research*, 2015, **3**.
3. G. Srikesh and A. S. Nesaraj, *Ceram. Int.*, 2016, **42**, 5001-5010.
4. I. H. Lo, J.-Y. Wang, K.-Y. Huang, J.-H. Huang and W. P. Kang, *J. Power Sources*, 2016, **308**, 29-36.
5. Z. Wang, F. Wang, J. Tu, D. Cao, X. An and Y. Ye, *Mater. Lett.*, 2016, **171**, 10-13.
6. M. Qorbani, N. Naseri and A. Z. Moshfegh, *ACS Appl. Mater. Inter.*, 2015, **7**, 11172-11179.
7. G. Gao, S. Lu, Y. Xiang, B. Dong, W. Yan and S. Ding, *Dalton Trans.*, 2015, **44**, 18737-18742.
8. G. Zhang and X. W. Lou, *Adv. Mater.*, 2013, **25**, 976-979.