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Comprehending the effect of $MMoO_4$ (M = Co, Ni) nanoflakes on improving the electrochemical performance of NiO electrodes

Lei An[a]†, Wenyao Li[a,b]†, Yunjiu Cao[a,c], Kaibing Xu[a], Rujia Zou[a,d] Tao Ji[a,c], Li Yu[a,e] and Junqing Hu[a]*

[a] State Key Laboratory for Modification of Chemical Fibers and Polymer Materials, College of Materials Science and Engineering, Donghua University, Shanghai 201620, China.

[b] School of Material Engineering, Shanghai University of Engineering Science, Shanghai 201620, China.

[c] School of Fundamental Studies, Shanghai University of Engineering Science, Shanghai 201620, China.

[d] Center of Super-Diamond and Advanced Films (COSDAF), Department of Physics and Materials Science, City University of Hong Kong, Hong Kong.

[e] Ian Wark Research Institute, University of South Australia, Mawson Lakes, SA 5095, Australia.

E-mail: hu.junqing@dhu.edu.cn

† These authors contributed equally to the work.

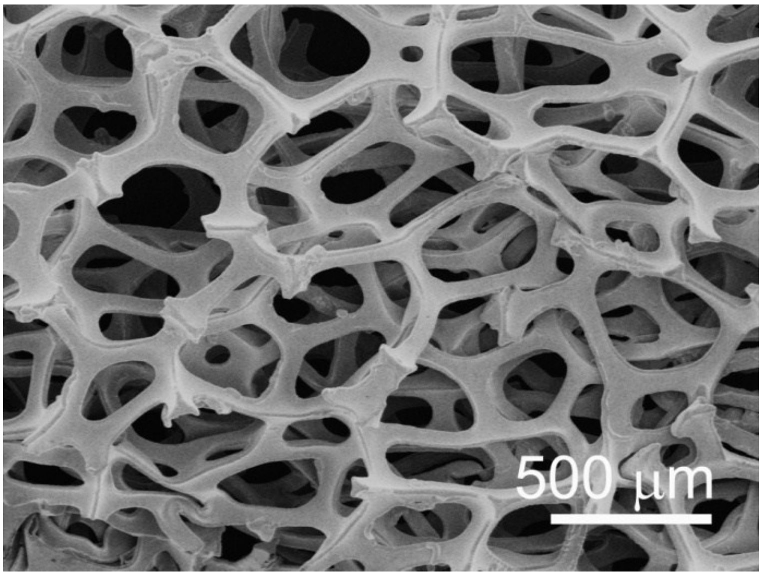

Fig. S1 SEM image of Ni foam.

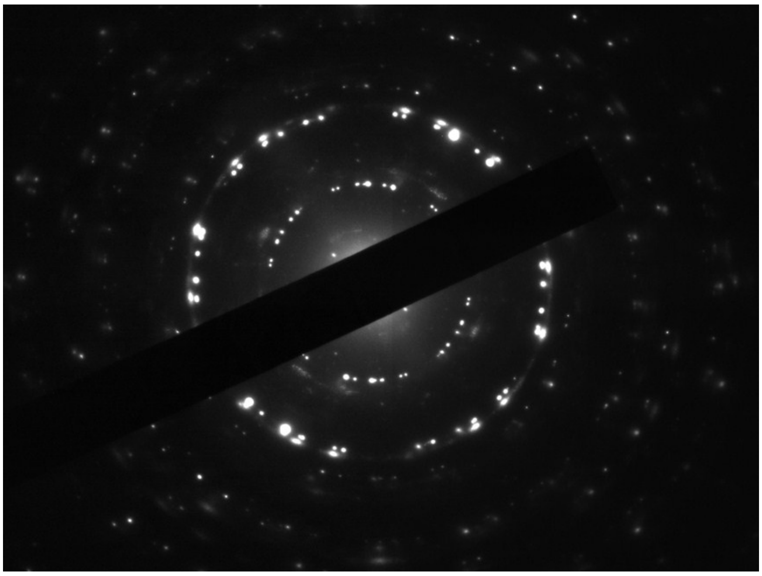

Fig. S2 The SAED image of the NiO nanosheets.

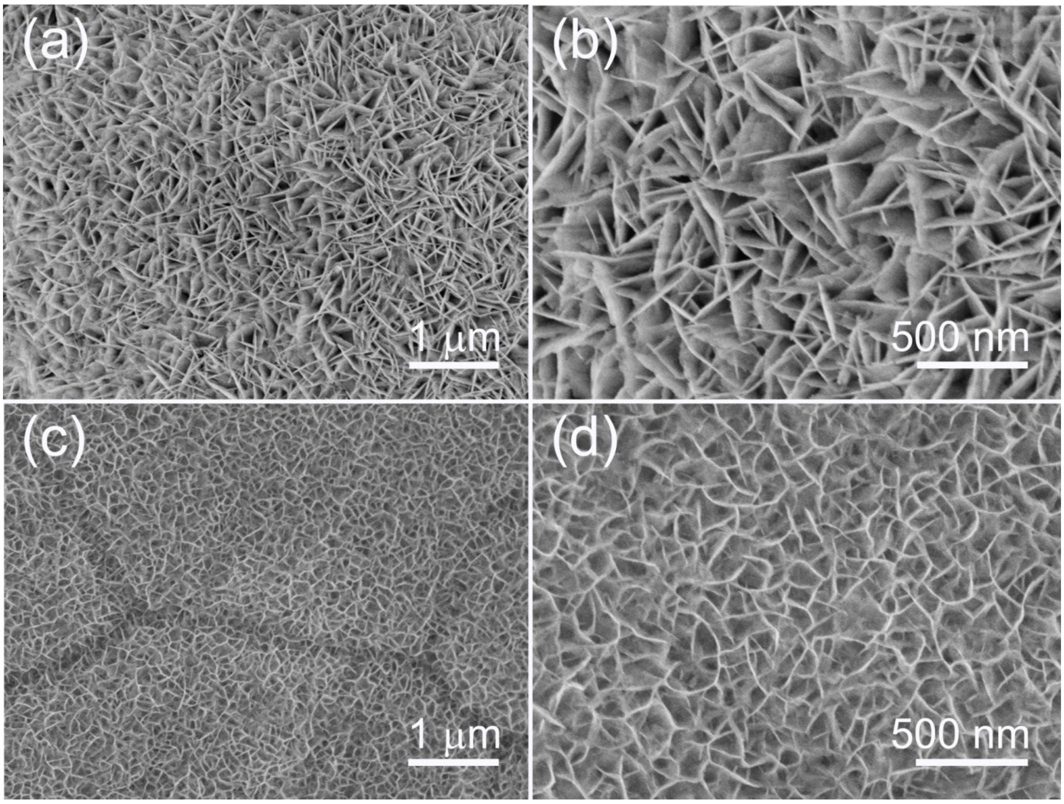

Fig. S3 Low- and high- SEM images of (a, b) $CoMoO_4$ and (c, d) $NiMoO_4$ nanoflakes directly grown on the Ni foam, respectively.

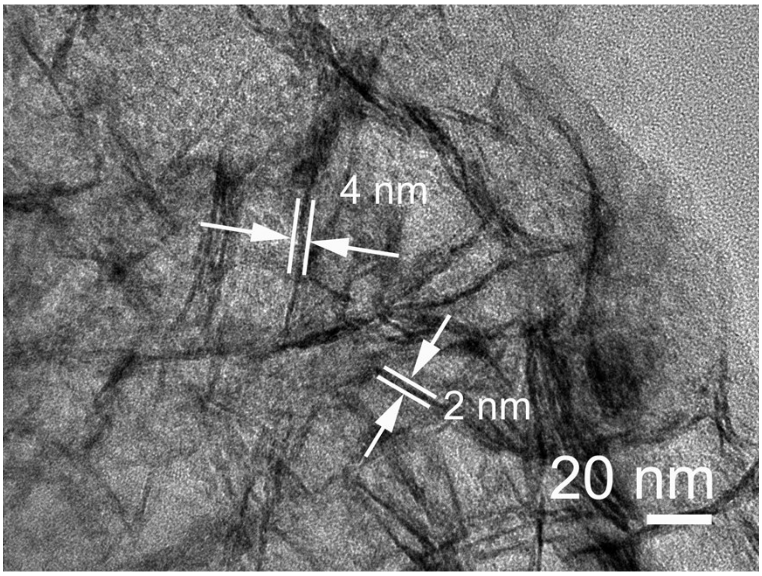

Fig. S4. TEM image of the NiO@$NiMoO_4$ hybrid composites, showing the ultrathin nature of $NiMoO_4$ nanoflakes.

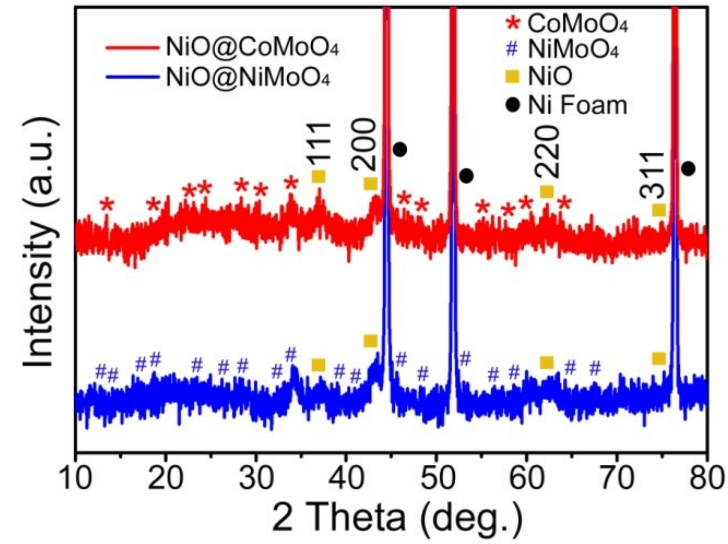

Fig. S5 XRD patterns of NiO@CoMoO$_4$ and NiO@NiMoO$_4$ hybrid composites on Ni foam.

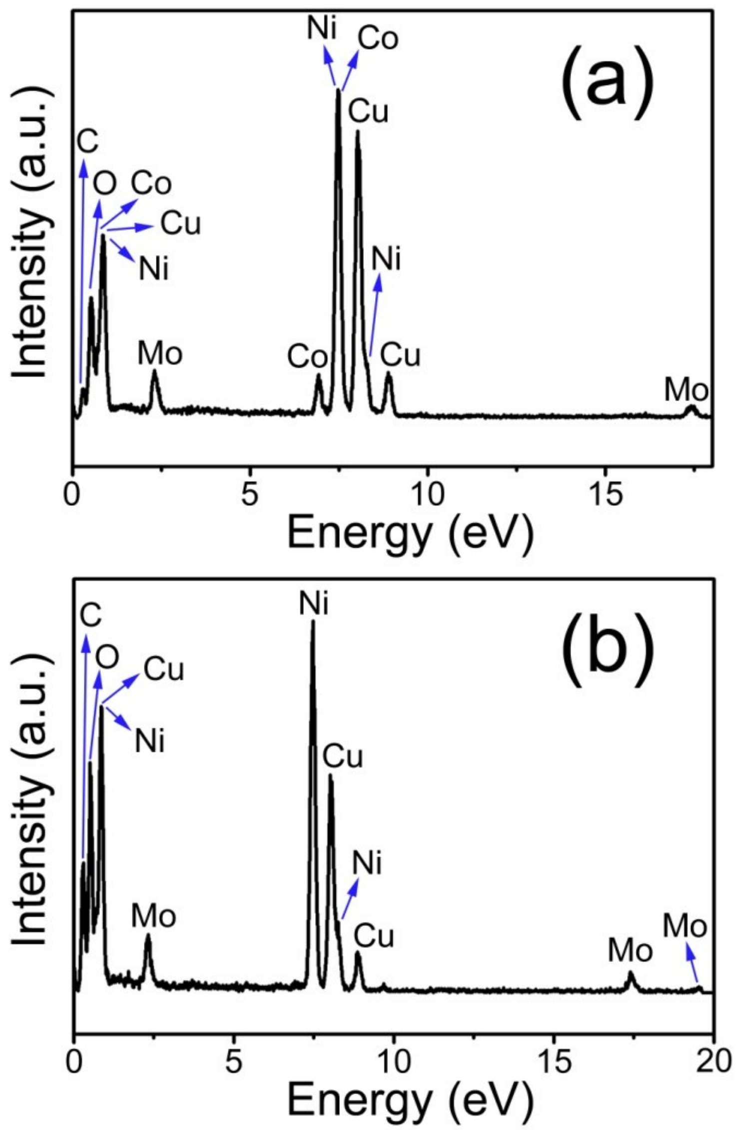

Fig. S6 EDX patterns of the (a) NiO@$CoMoO_4$ and (b) NiO@$NiMoO_4$ hybrid composites, respectively.

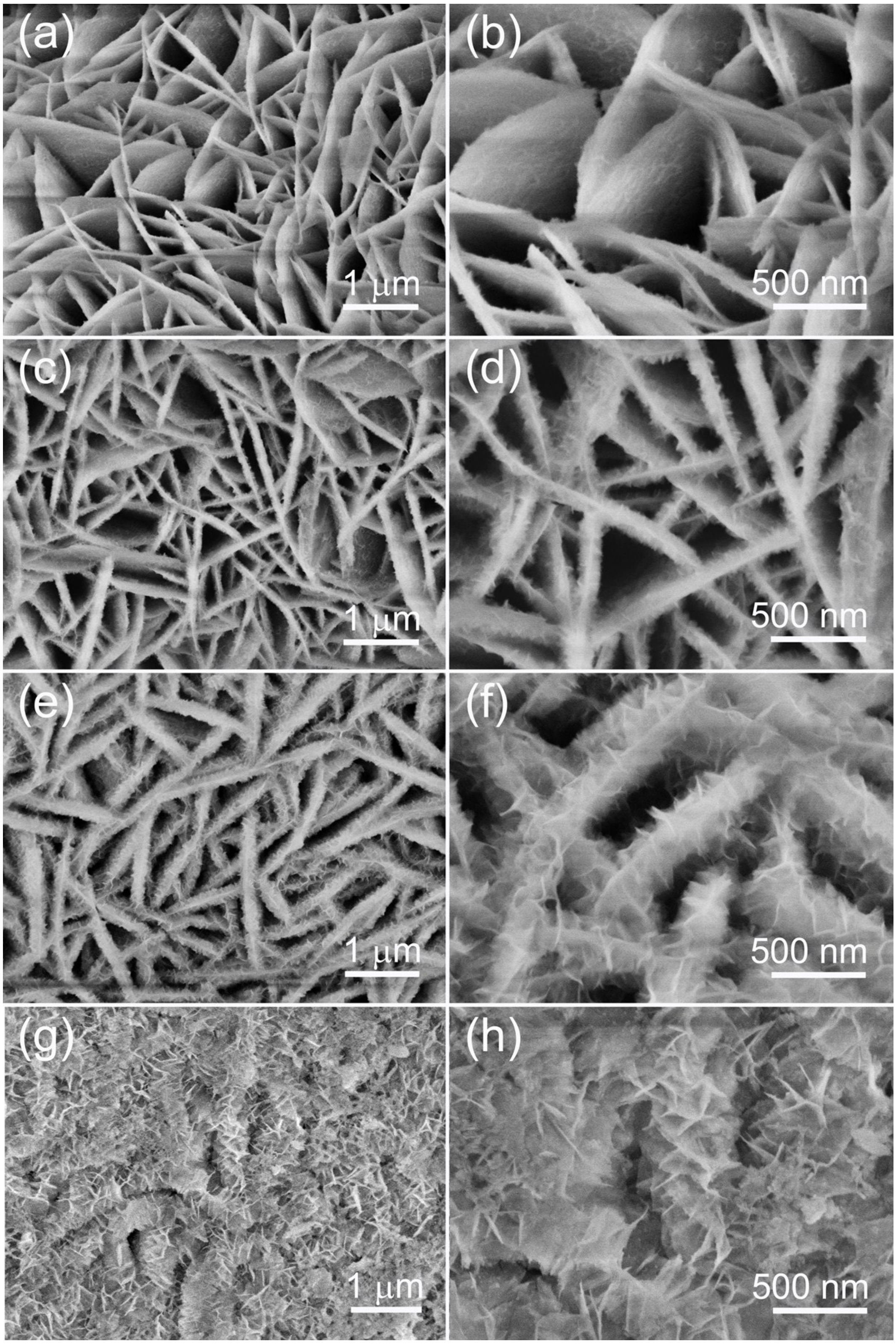

Fig. S7 SEM images of the morphology evolution of NiO@$NiMoO_4$ hybrid heterostructures at different reaction times. (a, b) 0.5 h, (c, d) 1 h, (e, f) 2 h, (g, f) 4 h.

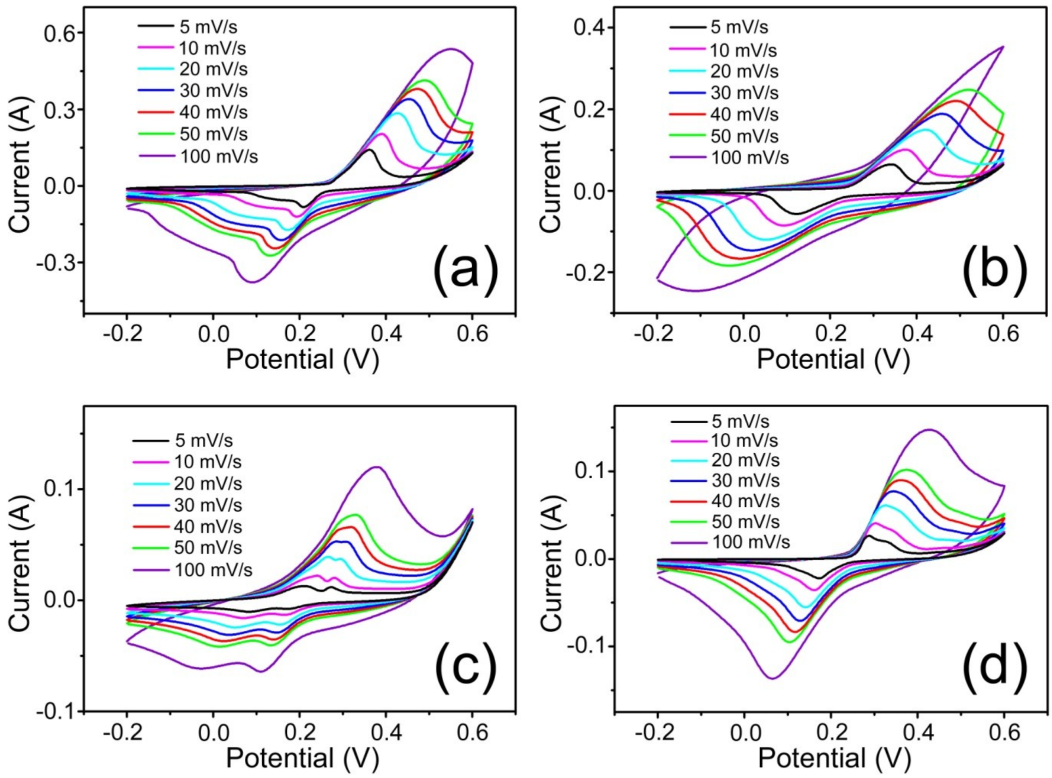

Fig. S8 CV curves at different scan rates of (a) NiO@$NiMoO_4$ hybrid composites, (b) NiO, (c) $CoMoO_4$ and (d) $NiMoO_4$ nanosheet arrays, respectively.

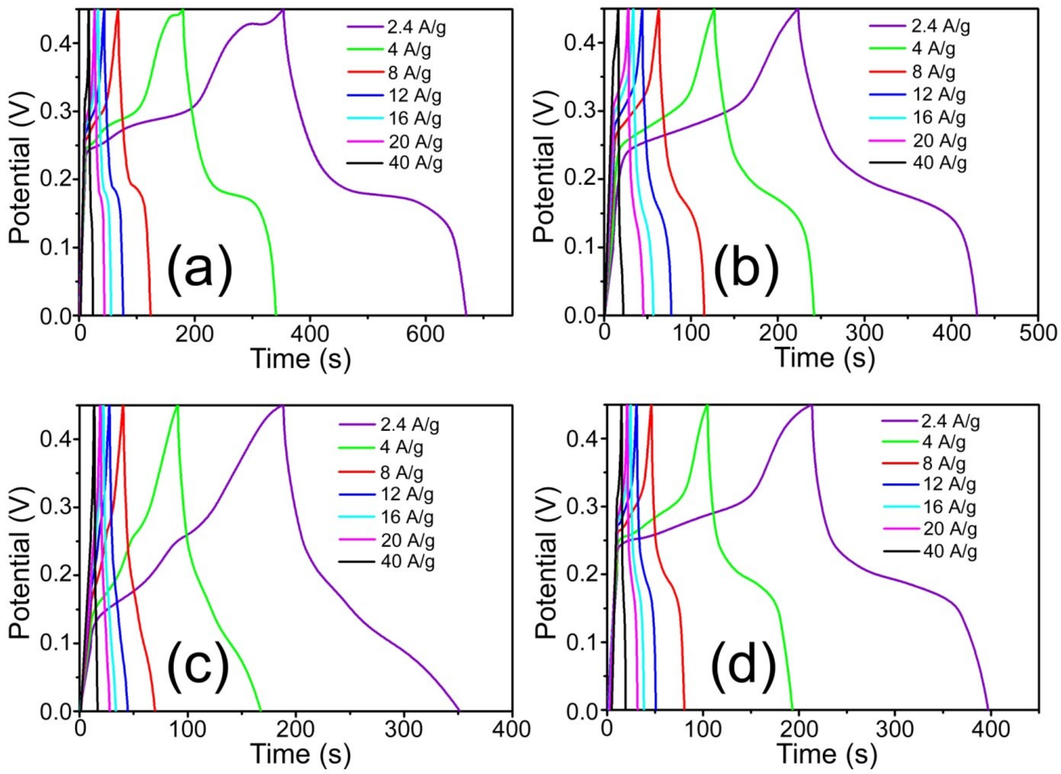

Fig. S9 Galvanostatic charge-discharge curves at different current densities of the (a) NiO@$NiMoO_4$ hybrid composites, (b) NiO, (c) $CoMoO_4$ and (d) $NiMoO_4$ nanosheet arrays, respectively.

Table S1 A comparison of the hierarchical NiO@$MMoO_4$ (M = Co, Ni) heterostructure electrode materials with other reported Ni- or Co- based electrodes in previous literatures.

Electrode Materials	Specific Capacitance	Ref.
NiO@$CoMoO_4$ heterostructures	1834 F g^{-1} at 2.4 A g^{-1}	This Work
NiO@$NiMoO_4$ heterostructures	1685 F g^{-1} at 2.4 A g^{-1}	This Work
NiO nano/microspheres	525 F g^{-1} at 4 A g^{-1}	17
Flower-like NiO structures	340 F g^{-1} at 1 A g^{-1}	18
Hierarchical NiO nanospheres	603 F g^{-1} at 0.5 A g^{-1}	19
rGO-supported $CoMoO_4$ nanorods	336.1 F g^{-1} at 1 A g^{-1}	42
NiO/Co_3O_4 core/shell composites	510 F g^{-1} at 5 mA cm^{-1}	43
$NiMoO_4$ nanotubes	864 F g^{-1} at 1 A g^{-1}	44
$NiMoO_4$ nanospheres	974.4 F g^{-1} at 1 A g^{-1}	45
$CoMoO_4$-$NiMoO_4$ • xH_2O bundles	1039 F g^{-1} at 2.5 mA cm^{-1}	46
$NiMoO_4$ • H_2O nanoclusters	680 F g^{-1} at 1 A g^{-1}	47
$MnMoO_4$/$CoMoO_4$ heterostructured nanowires	187.1 F g^{-1} at 1 A g^{-1}	48

Calculations

The specific capacitance (C) of the electrode was calculated from the discharge curves using the following formula[1]:

$$C = \frac{I \times \Delta t}{m \times \Delta V}$$

where I (A), Δt (s), m (g), and ΔV (V) are the discharge current, discharge time consumed in the potential range of ΔV, mass of the active materials, and the potential windows, respectively. In this work, the area of the working electrode immersed into the electrolyte was controlled to be ~ 1 cm^2 and the specific capacitance at 2.4 A g^{-1} were calculated as below:

For $NiO@CoMoO_4$ hybrid heterostructures electrode,

$$C = 11.352\ mA \times 344\ s / [(3.41+1.32)\ mg \times 0.45\ V] = 1834\ F\ g^{-1};$$

For $NiO@NiMoO_4$ hybrid heterostructures electrode,

$$C = 12\ mA \times 316\ s / [(3.79+1.21)\ mg \times 0.45\ V] = 1685\ F\ g^{-1};$$

For NiO nanosheets electrode,

$$C = 9.312\ mA \times 206\ s / (3.88\ mg \times 0.45\ V) = 1099\ F\ g^{-1};$$

For $CoMoO_4$ nanoflakes electrode,

$$C = 3.744\ mA \times 163.5\ s / (1.56\ mg \times 0.45\ V) = 872\ F\ g^{-1};$$

For $NiMoO_4$ nanoflakes electrode,

$$C = 3.48\ mA \times 183.5\ s / (1.45\ mg \times 0.45\ V) = 979\ F\ g^{-1}.$$

The energy density (E) and power density (P) are calculated from the discharge curves using the following formula:

E = **Error!** $\times C \times \Delta V^2$

$$P = \frac{E}{\Delta t}$$

1. J. Yan, E. Khoo, A. Sumboja and P. S. Lee. *ACS Nano*, 2010, **4**, 4247.