One-step solvothermal in situ synthesis of NiMOF nanosheets for high-performance supercapacitor applications

Xiaojing Wang [a], Fenglian Lu [b], Zongjin Wu [a], Kuantao Zhang [a], Song Li [b], Rui Tu [c], Sha Luo [c], Hongyan Pan [a,*], Keliang Wang [c,*], Qian Lin [a,*],

[a] *School of Chemistry and Chemical Engineering, Guizhou Key Laboratory for Green Chemical and Clean Energy Technology, Guizhou University, Guiyang, Guizhou 550025, China*

[b] *School of Chemistry and Materials Engineering, Liupanshui Normal University, Liupanshui, 553004, China*

[c] *Department of Brewing Engineering, Moutai Institute, Renhuai, 564501, China*

Corresponding Author:

Hongyan Pan *. E-mail: cepanhongyan@163.com

Keliang Wang *. E-mail: wangkeliang@mtxy.edu.cn

Qian Lin *. E-mail: celinqianphy@163.com

Supporting Material

Text S1

The morphological of NMFs was characteriaed by field emission scanning electron microscopy (SEM, ZEISS GeminiSEM 300). X-ray diffractometer (XRD, Rigaku Ultima IV) was used to collect the phase of the synthesized Ni-MOF sample at 10 ° min^{-1}, using Cu-K-α radiation. TEM images were obtained by transmission electron microscopy (FEI Tecnai G2 F20, USA). Fourier Transform Infrared (FTIR) Spectroscopy analysis by (FTIR iS 50) test specimens for group structure analysis, qualitative and quantitative analysis of materials. Nitrogen adsorption-desorption measurements were performed using a Micromeritics ASAP 2020 adsorption meter. The surface species and chemical state of the samples were analysed by high-resolution X-ray photoelectron spectroscopy (XPS, ESCALAB Xi+), incorporating the C 1s peak at the energy reference 284.8 eV.

Text S2

The electrochemical properties of all NMFs electrode materials were tested by CHI 760 E potentiostat electrochemical workstation. Firstly, in the three-electrode system, 3 M KOH was used as the electrolyte, NMFs (1 cm×1 cm) was used as the working electrode, platinum was used as the counter electrode, and saturated calomel electrode (Hg/HgO) was used as the reference electrode. The electrode materials were tested by cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS). For the two-electrode test was carried out. In order to prepare the negative electrode of asymmetric supercapacitor (ASC), activated carbon (AC), conductive carbon black and polytetrafluoroethylene (PVDF) were mixed and ground into a slurry in a ratio of 8 : 1 : 1, uniformly coated on nickel foam, and dried in an oven at 60 °C for 12 h. The CV of the cathode material was tested within a voltage window of 0-0.6 V, the GCD was tested in the range of 0-0.5 V, and the EIS was measured in the frequency range of 0.01-100 kHz with an amplitude of 5 mV. The specific capacitance (C, F g^{-1}) of the NMFs electrode material is calculated by the following formula :

$$C = \frac{I\,\Delta t}{m\,\Delta V} \tag{1}$$

In this equation, I (A), Δt (s), ΔV (V) and m (g) represent the discharge current, discharge time, voltage window and the mass of the active substance, respectively.

In the two-electrode system, ASC was assembled with NMF-1 as the positive electrode and AC as the negative electrode, and the two-electrode test was carried out. To ensure the charge matching between the positive and negative electrode is required, and the following formula is used for quality matching：

$$\frac{m^{+}}{m^{-}}=\frac{C^{-}\ \triangle V^{-}}{C^{+}\ \triangle V^{+}} \tag{2}$$

Among them, m, C and ΔV represent the mass (g), specific capacitance (F g^{-1}) and voltage window (V) of the positive and negative active materials, respectively.

Then Energy density E (Wh / kg) and power density P (W / kg) were calculated using eqs (3) and (4)：

$$E=\frac{C\times(\triangle V)^{2}}{2\times 3.6} \tag{3}$$

$$P=\frac{3600E}{\triangle t} \tag{4}$$

C (F g^{-1}) represents the specific capacity, ΔV (V) represents the voltage window, and Δt (s) represents the discharge time.

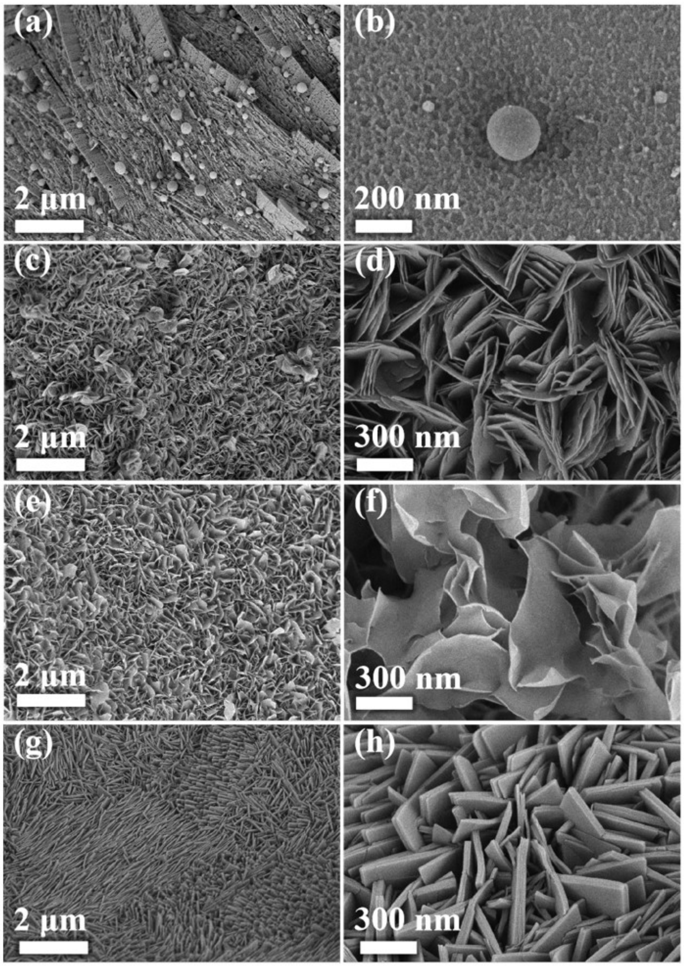

Fig. S1. SEM image of (a,b) NMF-0, (c,d) NMF-0.5, (e,f) NMF-2, and (g-h) NMF-5

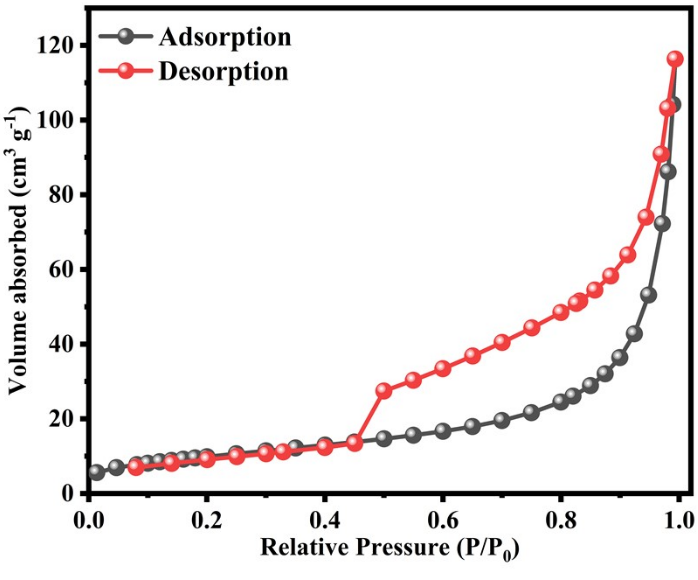

Fig. S2. N_2 adsorption-desorption isotherms of NMF-1

Table S1. Specific Capacitance of typical MOF-based electrode Materials in KOH electrolyte solution

NO.	sample	Current density(A g^{-1})	Specific capacitance(F g^{-1})	Ref
1	NMF-1 nanosheets	1	1238	This Work
2	NM-1 nanoflowers	1	1093	1 [1]
3	hierarchical porous Ni-MOF	1	1057	2 [2]
4	moss like3D Ni-MOF	0.5	1276	3 [3]
5	2D-Ni-MOF	0.5	1127	4 [4]
6	accordion-like Ni-MOF	0.7	1021	5 [5]
7	N-0.5 MOF	1	1004.67	6 [6]

Table S2. Rs and Rct Values of the Prepared NMFs

Electrode samples	Rs(Ω)	Rct(Ω)
NMF-0	0.81	8.53
NMF-0.5	1.04	5.85
NMF-1	0.83	4.79
NMF-2	0.81	6.35
NMF-5	0.78	7.55

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