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

Supporting information

Mixed-metallic MOFs based electrode materials for high performance hybrid supercapacitors

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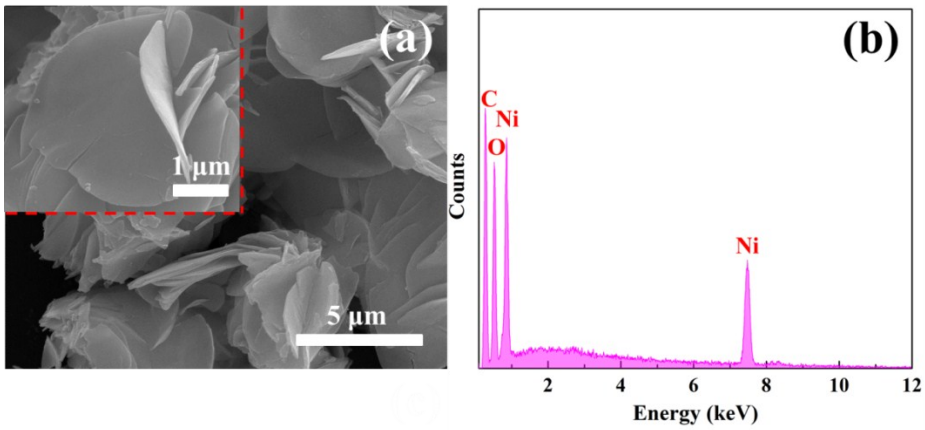

Fig. S1. (a) Typical SEM images of Ni-MOF and (b) EDS spectrum of Ni-MOF

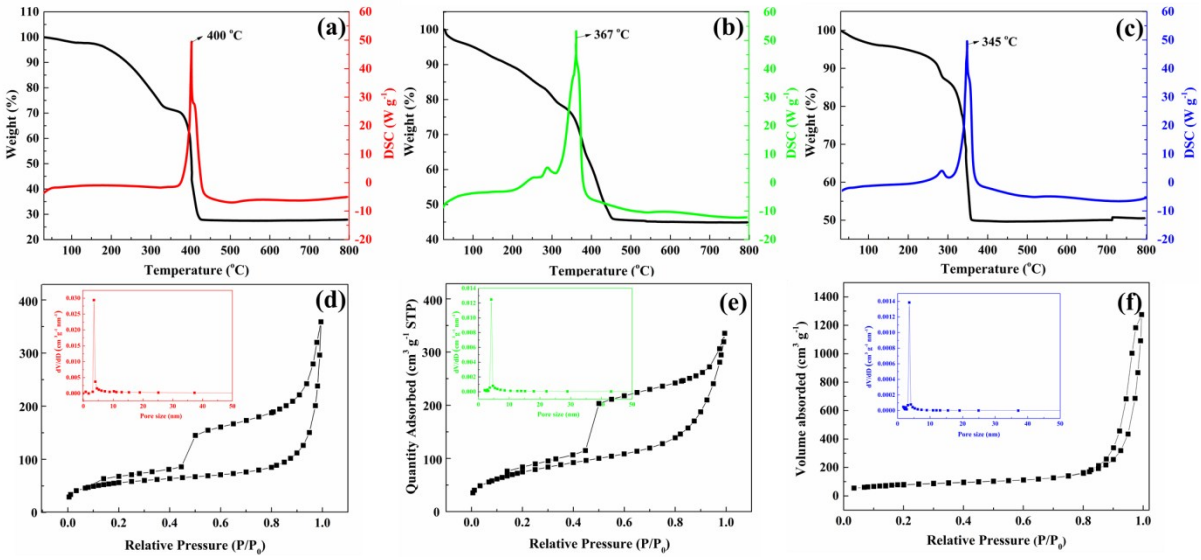

Fig. S2. The TG-DSC curves of (a) Co/Ni-MOF (b) Zn/Ni-MOF and (c) Ni-MOF. The N_2 adsorption and desorption isotherms of (d) Co/Ni-MOF (e) Zn/Ni-MOF and (f) Ni-MOF (inset is the pore size distributions of the MOFs).

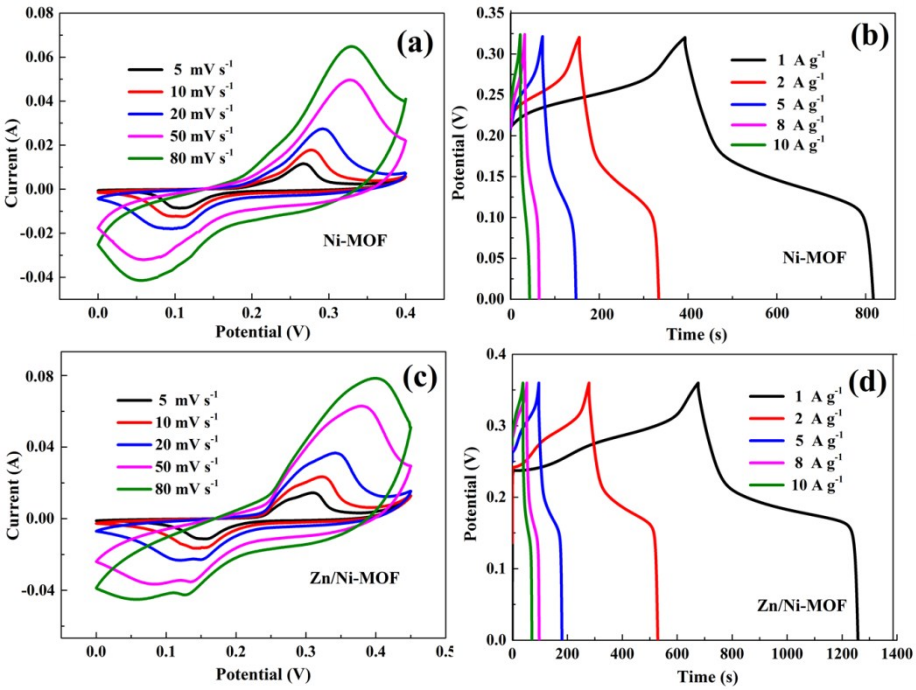

Fig. S3. (a, c) Cyclic voltammograms of Ni-MOF and Zn/Ni-MOF at different scan rates, respectively; (b, d) Charge-discharge curves of Ni-MOF and Zn/Ni-MOF at different current densities, respectively.

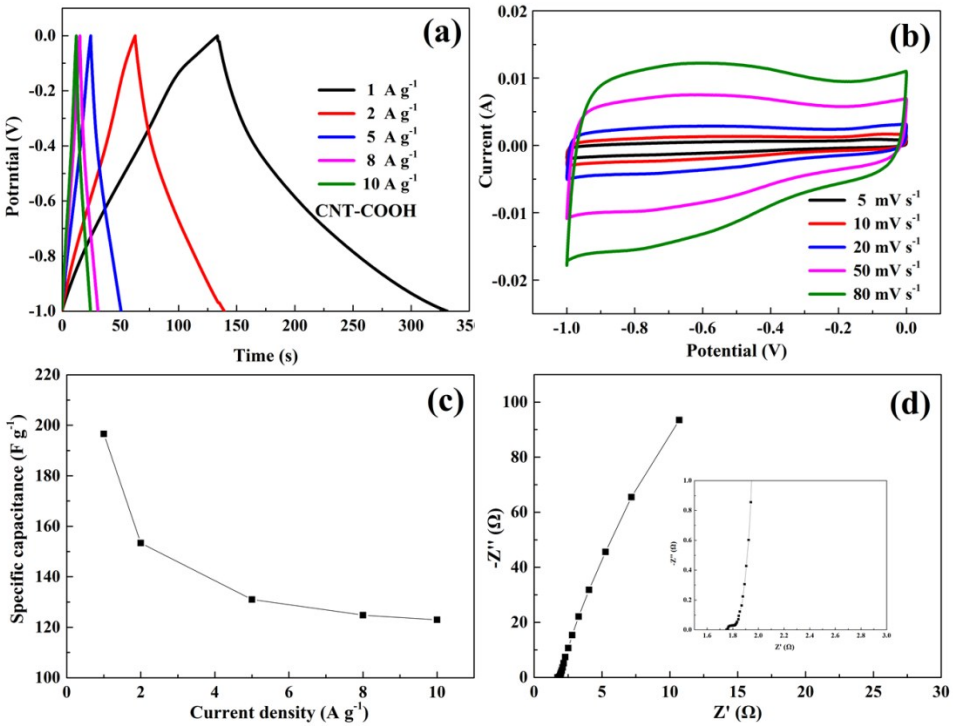

Fig. S4. (a) Charge and discharge curves of CNTs-COOH at different current densities ranged from 1 to 10 A g^{-1}. (b) CV curves of CNTs-COOH at the scan rate between 5 and 80 mV s^{-1}. (c) Specific capacity as a function of current density. (d) Nyquist plots of the CNTs-COOH.

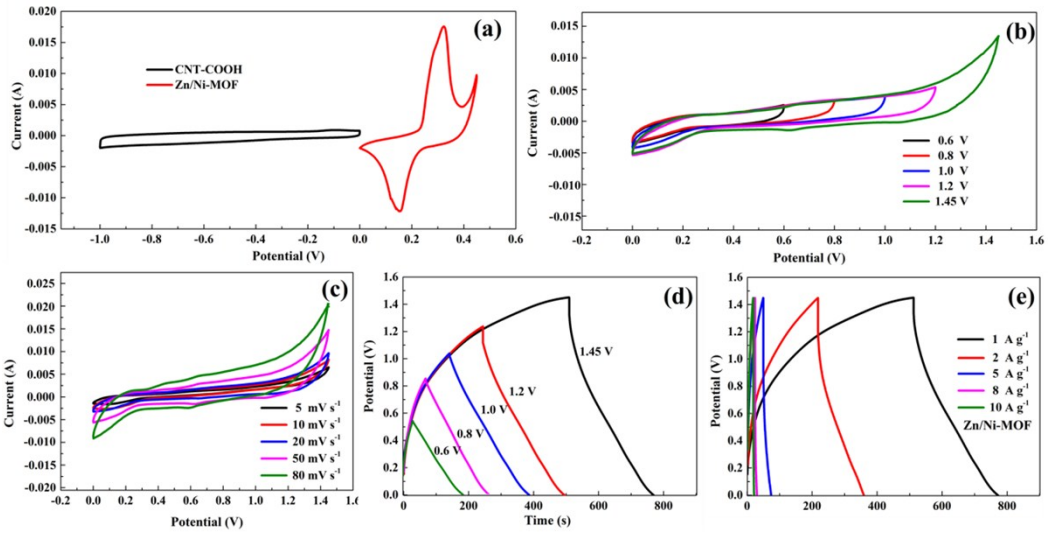

Fig. S5. (a) Cyclic voltammetry curves of the Zn/Ni-MOF and CNT-COOH electrodes performed in a three-electrode cell in a 3 M KOH electrolyte at a scan rate of 5 mV s^{-1}; (b) CV curves at the different potentials (50 mV s^{-1}); (c) Cyclic voltammetry curves at the different scan rates; (d) Charge-discharge curves at the different potentials (1 A g^{-1}); (e) Charge-discharge curves at the different current density.

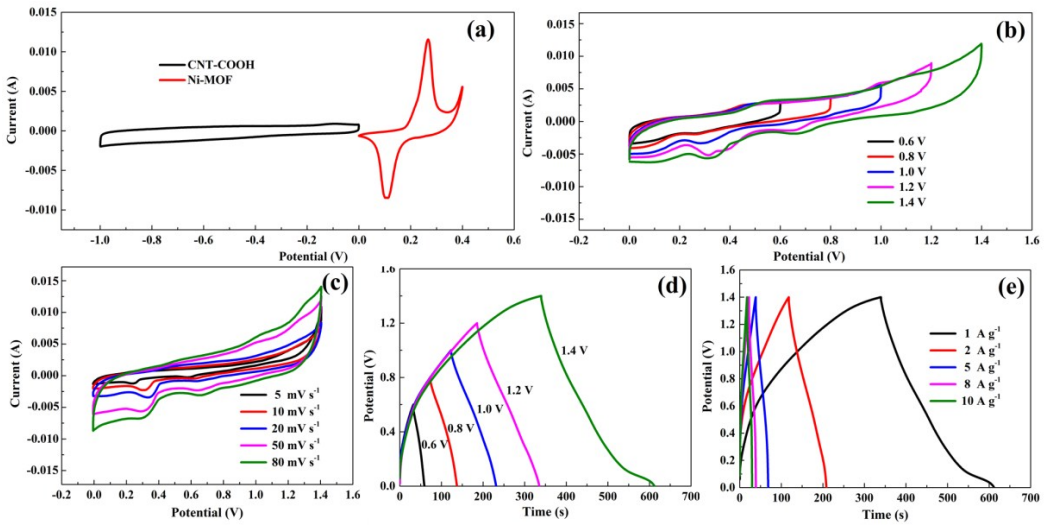

Fig. S6. (a) Cyclic voltammetry curves of the Ni-MOF and CNT-COOH electrodes performed in a three-electrode cell in a 3 M KOH electrolyte at a scan rate of 5 mV s^{-1}; (b) CV curves at the different potentials (50 mV s^{-1}); (c) Cyclic voltammetry curves at the different scan rates; (d) Charge-discharge curves at the different potentials (1 A g^{-1}); (e) Charge-discharge curves at the different current density

Table S1 Ions ratio of metals in M-MOFs determined by ICP analysis.

Sample	Ni%	Co%	Zn%
Ni-MOF	100	0	0
Co/Ni-MOF	77	23	0
Zn/Ni-MOF	78	0	22

Table S2 Various performance parameters for our Co/Ni-MOF//CNT-COOH Asymmetric Supercapacitors

Current density ($A \cdot g^{-1}$)	Discharge time (s)	Capacitance ($F \cdot g^{-1}$)	Energy density ($W \cdot h \cdot kg^{-1}$)	Power density ($W \cdot kg^{-1}$)
1	307	211.7	61.8	725
2	135.7	187	54.7	1450
5	42.9	147.8	43	3625
8	19.7	108.7	31.7	5800
10	14.3	98.6	28.7	7250

Table S3 Various performance parameters for our Zn/Ni-MOF//CNT-COOH Asymmetric Supercapacitors

Current density ($A \cdot g^{-1}$)	Discharge time (s)	Capacitance ($F \cdot g^{-1}$)	Energy density ($W \cdot h \cdot kg^{-1}$)	Power density ($W \cdot kg^{-1}$)
1	266	183.4	53.6	725
2	123	169.7	49.5	1450
5	35.7	123	36	3625
8	18.3	101	29.5	5800
10	13	89.7	26.1	7250

Table S4 Various performance parameters for our Ni-MOF//CNT-COOH Asymmetric Supercapacitors

Current density ($A \cdot g^{-1}$)	Discharge time (s)	Capacitance ($F \cdot g^{-1}$)	Energy density ($W \cdot h \cdot kg^{-1}$)	Power density ($W \cdot kg^{-1}$)
1	255.6	182.6	49.7	700
2	97	138.6	37.7	1400
5	33.3	118.9	32.3	3500
8	18.1	103.4	28.1	5600
10	11.7	83.6	22.8	7000

Table S5 Comparison of electrochemistry performance of electrochemical energy stored devices fabricated in our work with others reported.

Materials	Counter	Electrolyte	Potential Window (V)	Energy Density ($W \cdot h \cdot Kg^{-1}$)	Power Density ($W \cdot Kg^{-1}$)	Ref.
SP@rGO	SP@rGO@Co	2 M KOH	1.5	33.01	800	[1]
NiO	rGO	1 M KOH	1.7	39.9	360	[2]
MWCNT/amor-$Ni(OH)_2$ /PEDOT:PSS	rGO/CNT	1 M KOH	1.5	58.5	780	[3]
Ni-MOF/CNT	rGO/C_3N_4	6 M KOH	1.6	36.6	480	[4]
Ni-MOF	CNTs-COOH	3 M KOH	1.4	49.7	700	Our Work
Zn/Ni-MOF	CNTs-COOH	3 M KOH	1.45	53.6	725	Our Work

Co/Ni-MOF	CNTs-COOH	3 M KOH	1.45	61.8	725	Our Work

SP: macroporous 3D sponge
MWCNT: multiwalled carbon nanotube
PEDOT:PSS: poly (3,4-ethylenedioxythiophene)-poly(styrenesulfonate)
rGO: reduced graphene oxide
CNT: carbon nanotube

References

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2. F. Luan, G. Wang, Y. Ling, X. Lu, H. Wang, Y. Tong, X. X. Liu, Y. Li, *Nanoscale*, 2013, **5**, 7984–7990.

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