Electronic Supplementary Information

Rational design and synthesis of $Ni_xCo_{3-x}O_4$ nanoparticles derived from MOF-74 as high-performance supercapacitor electrodes

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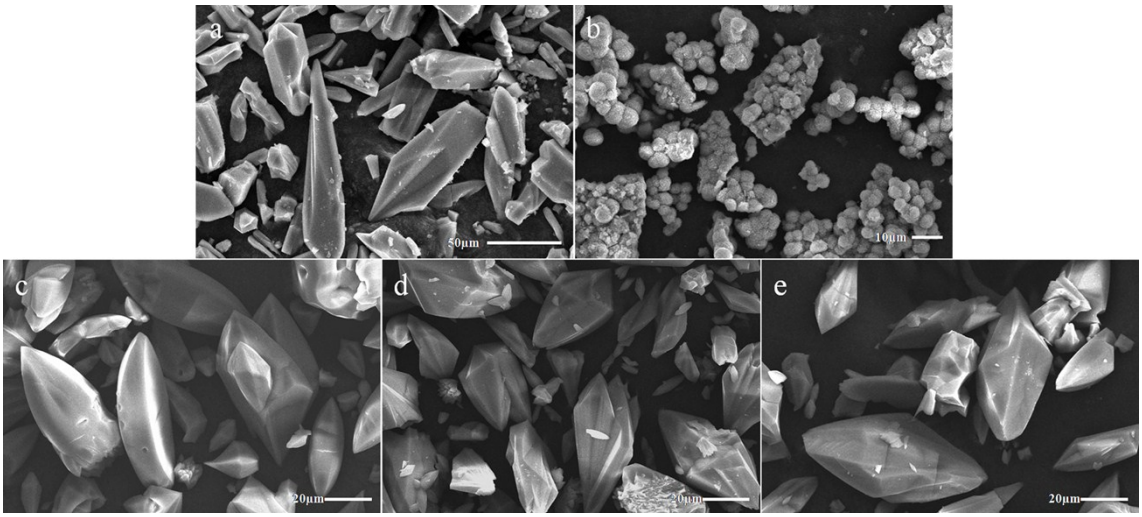


Figure S1. SEM images of: (a) MOF-74-Co, (b) MOF-74-Ni, (c) MOF-74-NiCo1, (d) MOF-74-NiCo2 and (e) MOF-74-NiCo4 samples.

2. Elemental Mappings of mix-metal MOF-74

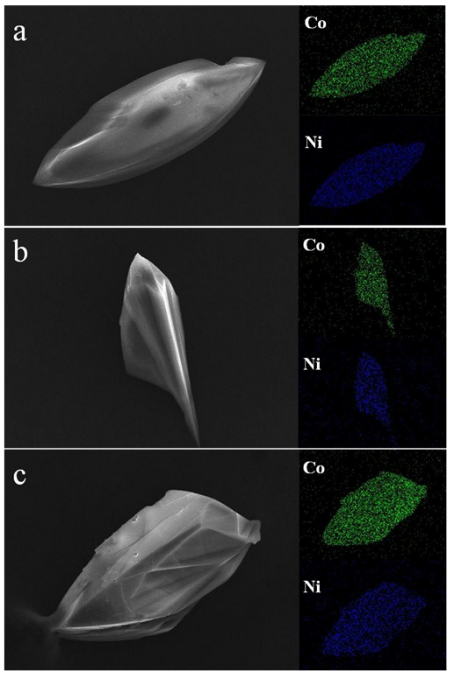


Figure S2. Elemental Mappings of: (a) MOF-74-NiCo1, (b) MOF-74-NiCo2 and (c) MOF-74-NiCo4.

3. EDS of MOF-74

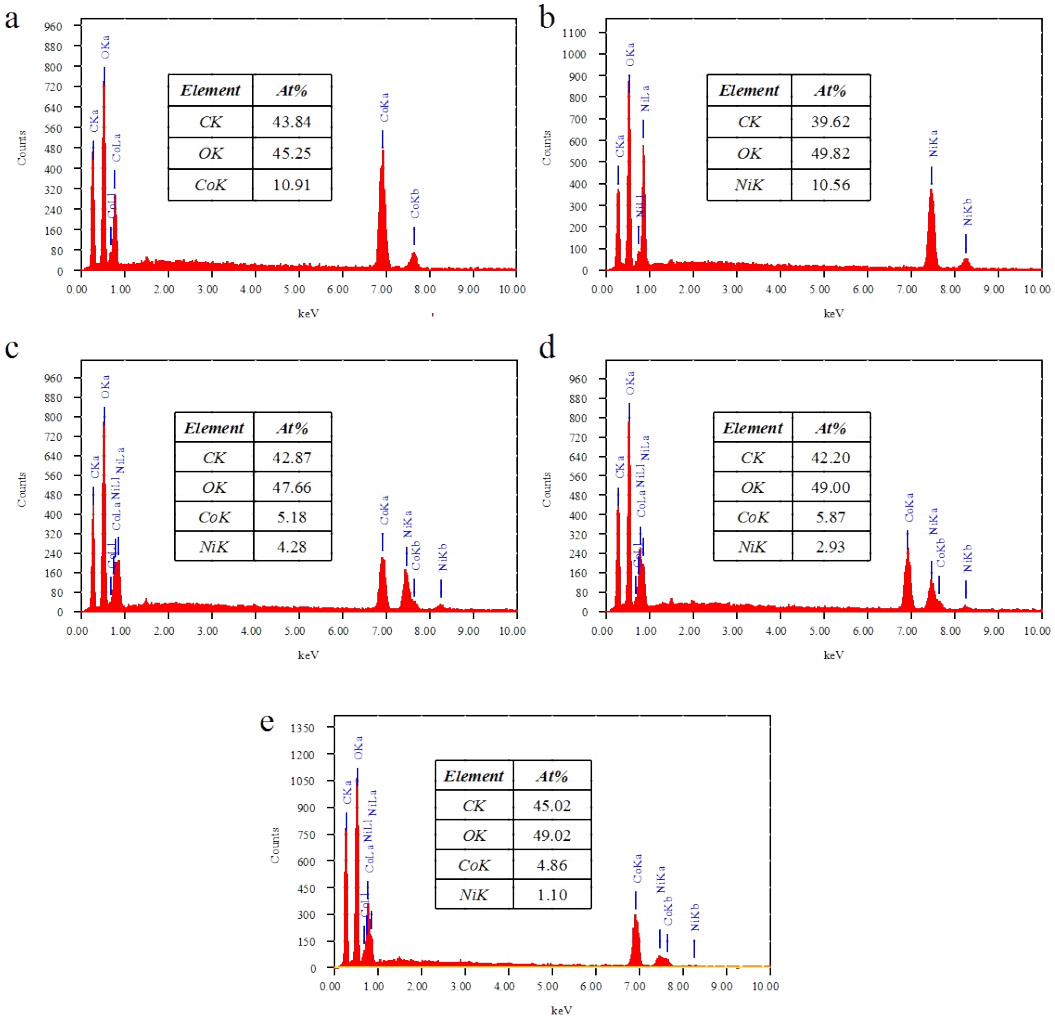


Figure S3. EDS of: (a) MOF-74-Co, (b) MOF-74-Ni, (c) MOF-74-NiCo1, (d) MOF-74-NiCo2 and (e)MOF-74-NiCo4 samples.

4. Thermogravimetric Analysis

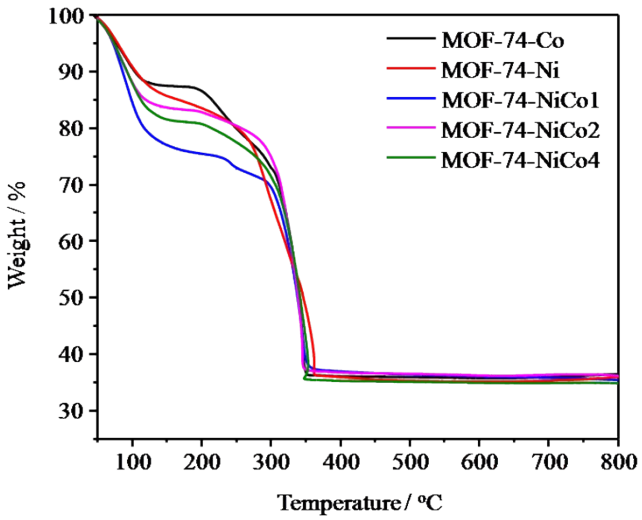


Figure S4. TGA curves of: MOF-74-Co, MOF-74-Ni, MOF-74-NiCo1, MOF-74-NiCo2 and MOF-74-NiCo4 samples under air atmosphere.

5. SEM images of metal oxide

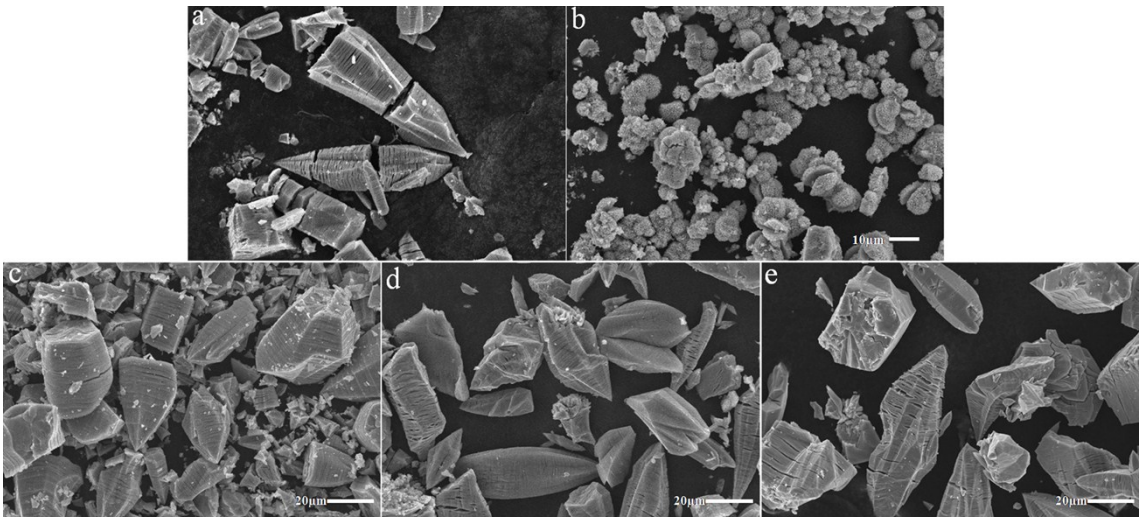


Figure S5. SEM images of: (a) Co_3O_4, (b) NiO, (c) $Ni_xCo_{3-x}O_4$-1, (c) $Ni_xCo_{3-x}O_4$-2 and (d) $Ni_xCo_{3-x}O_4$-4 samples.

6. TEM images of metal oxides

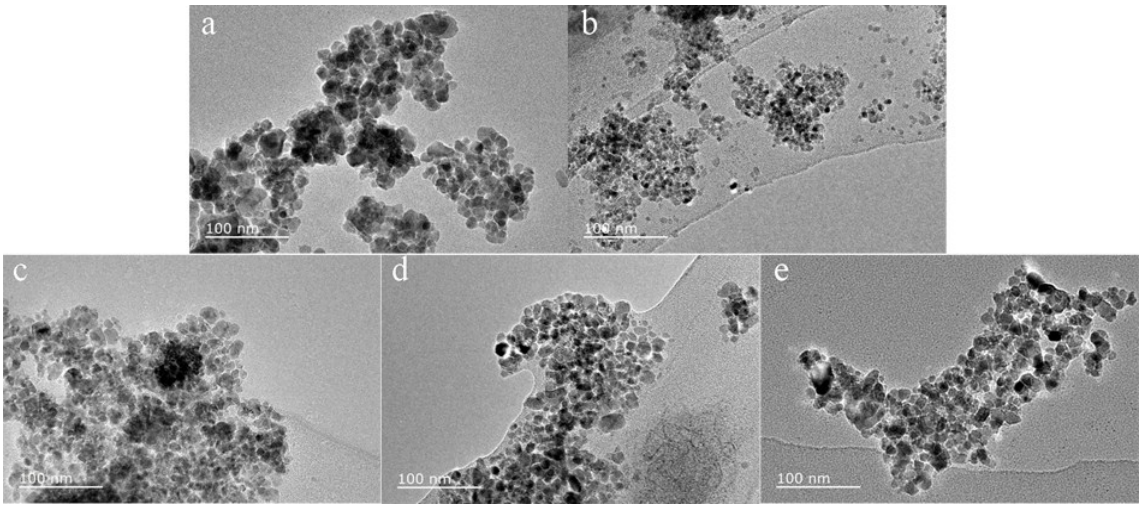
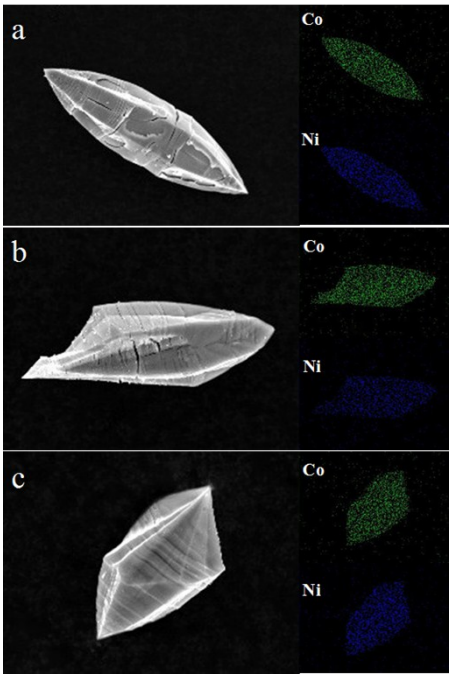


Figure S6 TEM images of: (a) Co_3O_4, (b) NiO, (c) $Ni_xCo_{3-x}O_4$-1, (c) $Ni_xCo_{3-x}O_4$-2 and (d) $Ni_xCo_{3-x}O_4$-4 samples.

7. Elemental Mappings of mix-metal oxides



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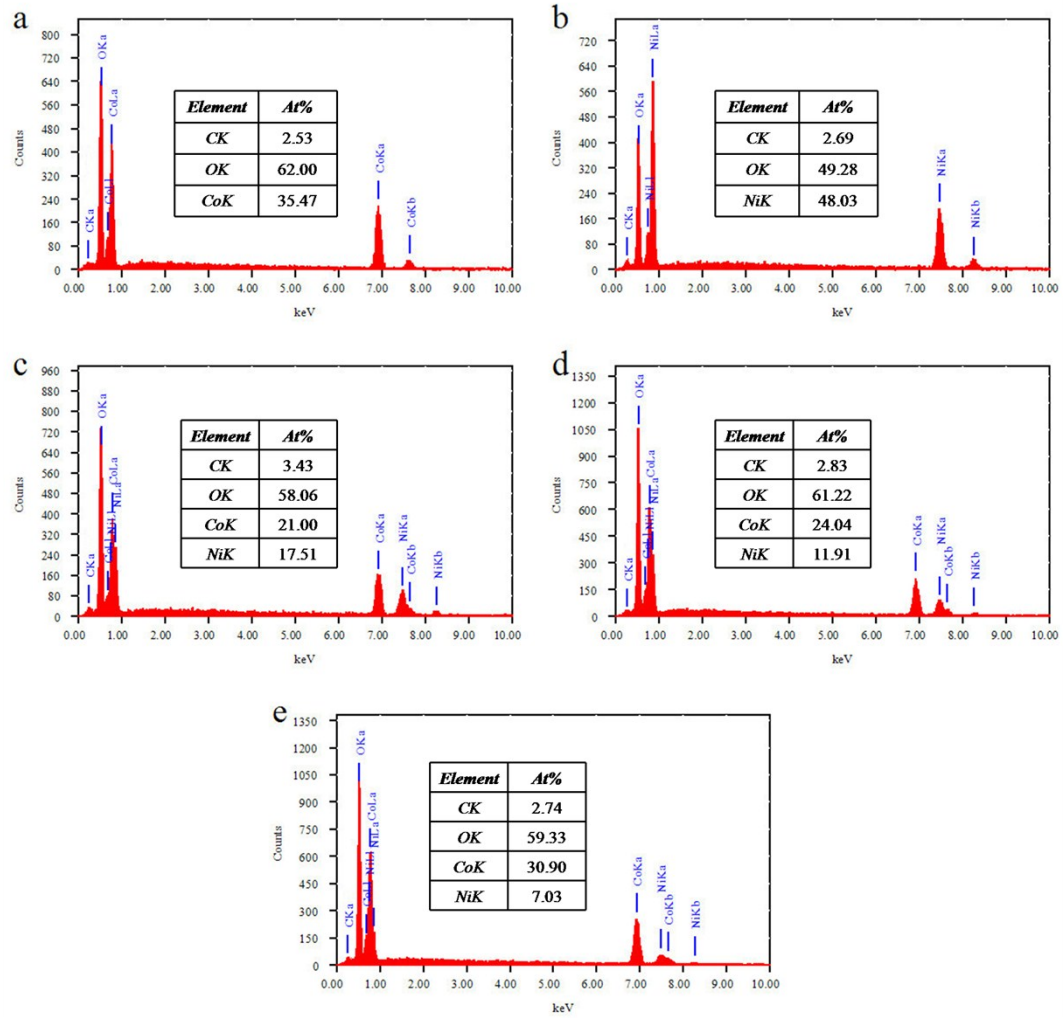

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9. XPS Analysis

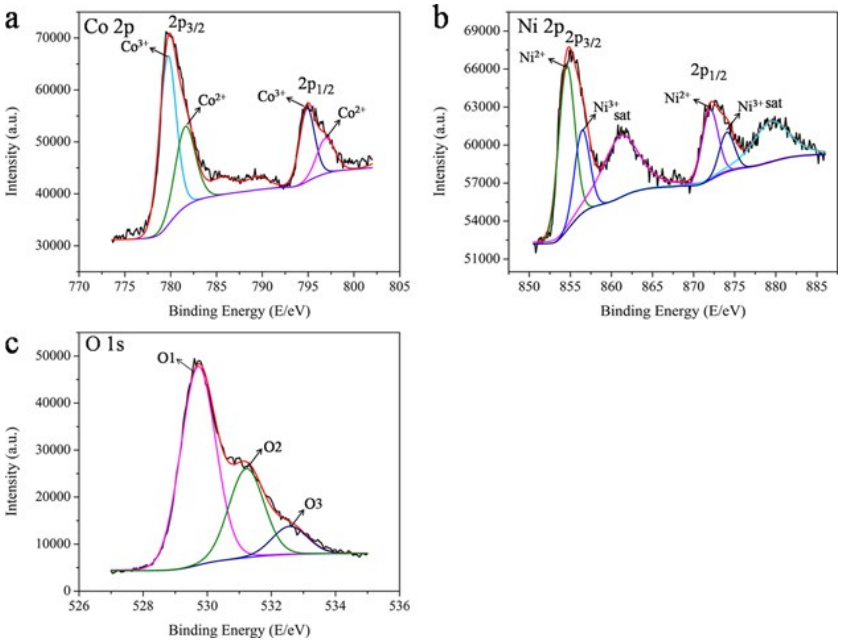
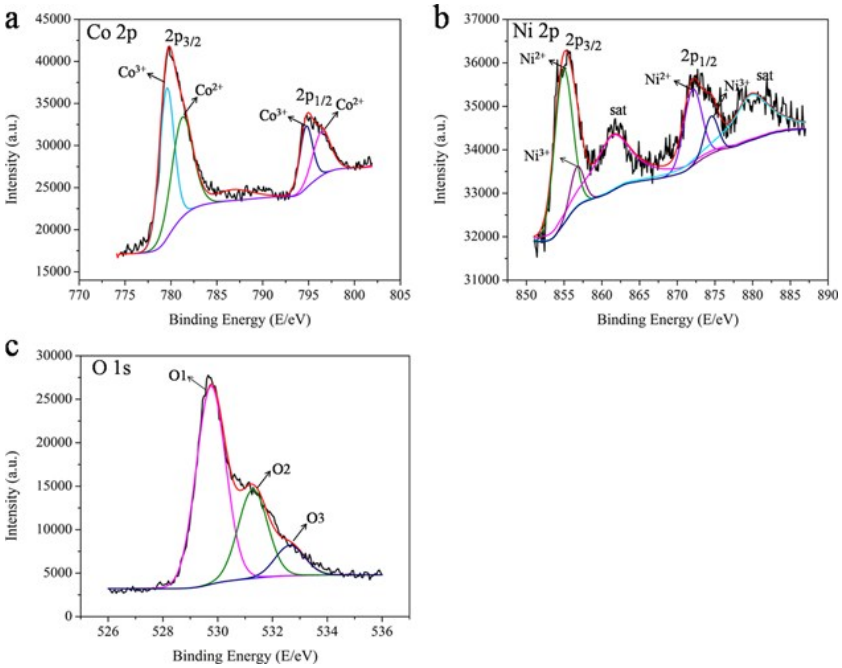


Figure S9. (a) Co 2p; (b) Ni 2p; and (c) O1s XPS spectra of the as-prepared $Ni_xCo_{3-x}O_4$-2 sample.



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10. PXRD of MOF-74-CoNi2, MOF-74-CoNi4 and synthesized metal oxides.

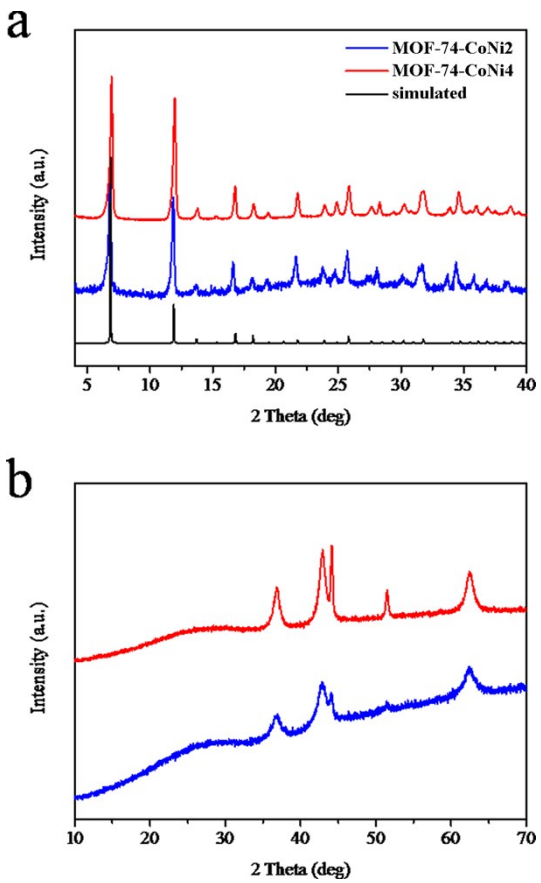


Figure S11. PXRD of (a) MOF-74-CoNi2 and MOF-74-CoNi4; (b) the synthesized metal oxides.

11. HRTEM images

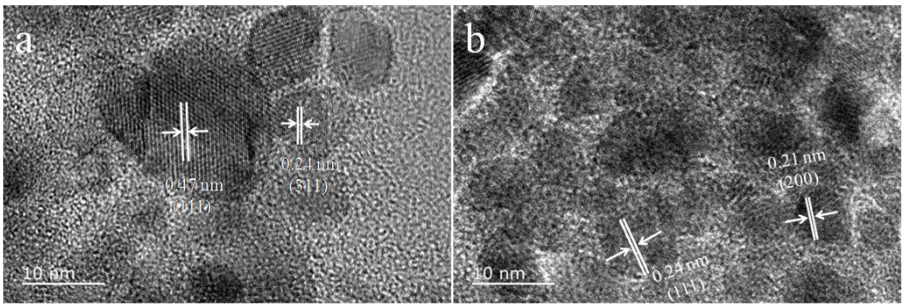
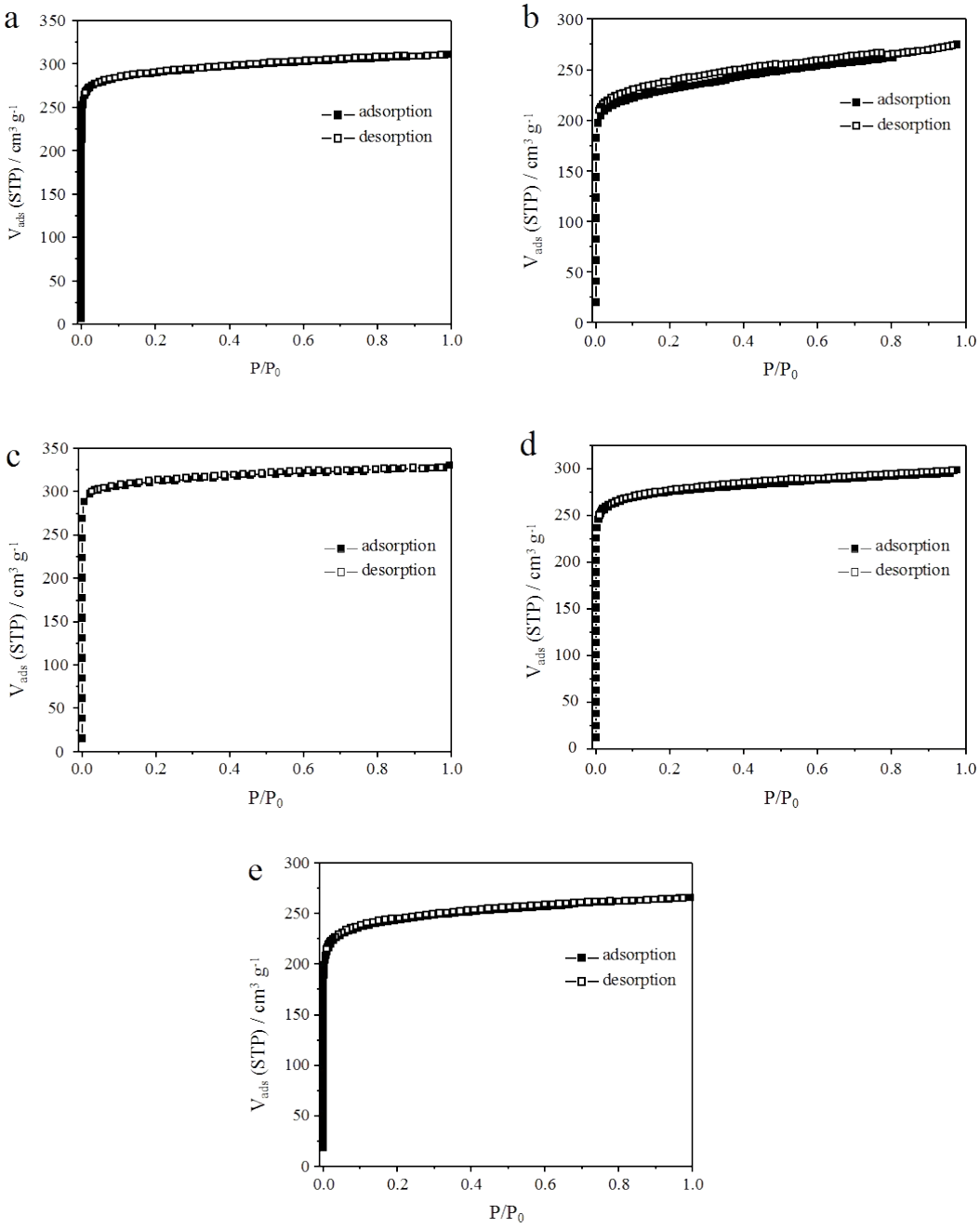


Figure S12. HRTEM images: (a) Co_3O_4 and (b) NiO samples.

12. Low-Pressure N_2 Sorption measurements of MOF-74



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13. Low-Pressure N_2 Sorption measurements of metal oxides.

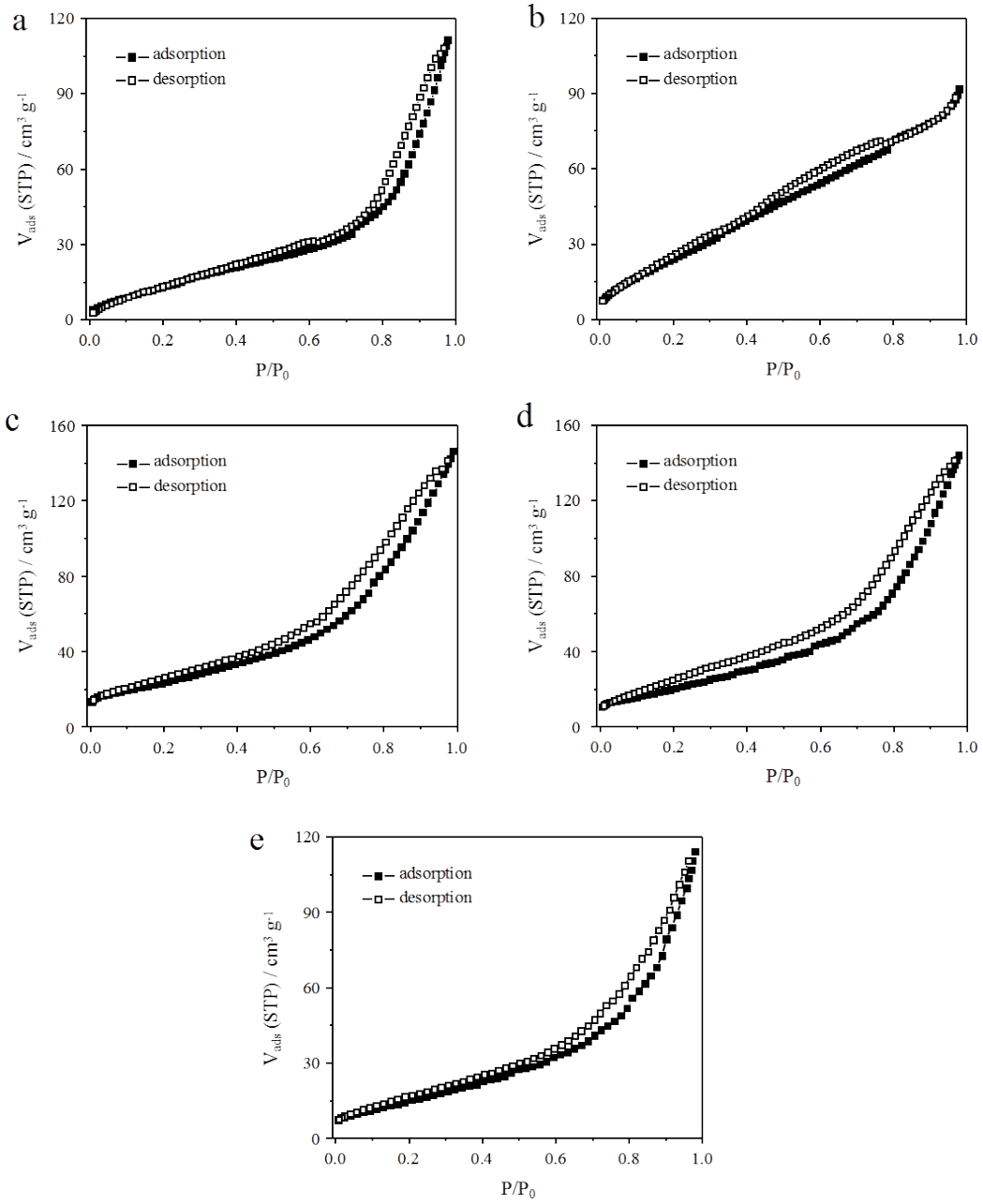

Figure S14. Nitrogen sorption isotherms of: (a) Co_3O_4, (b) NiO, (c) $Ni_xCo_{3-x}O_4$-1, (d) $Ni_xCo_{3-x}O_4$-2 and (e) $Ni_xCo_{3-x}O_4$-4 samples.

14. Cyclic voltammetry (CV) measurements

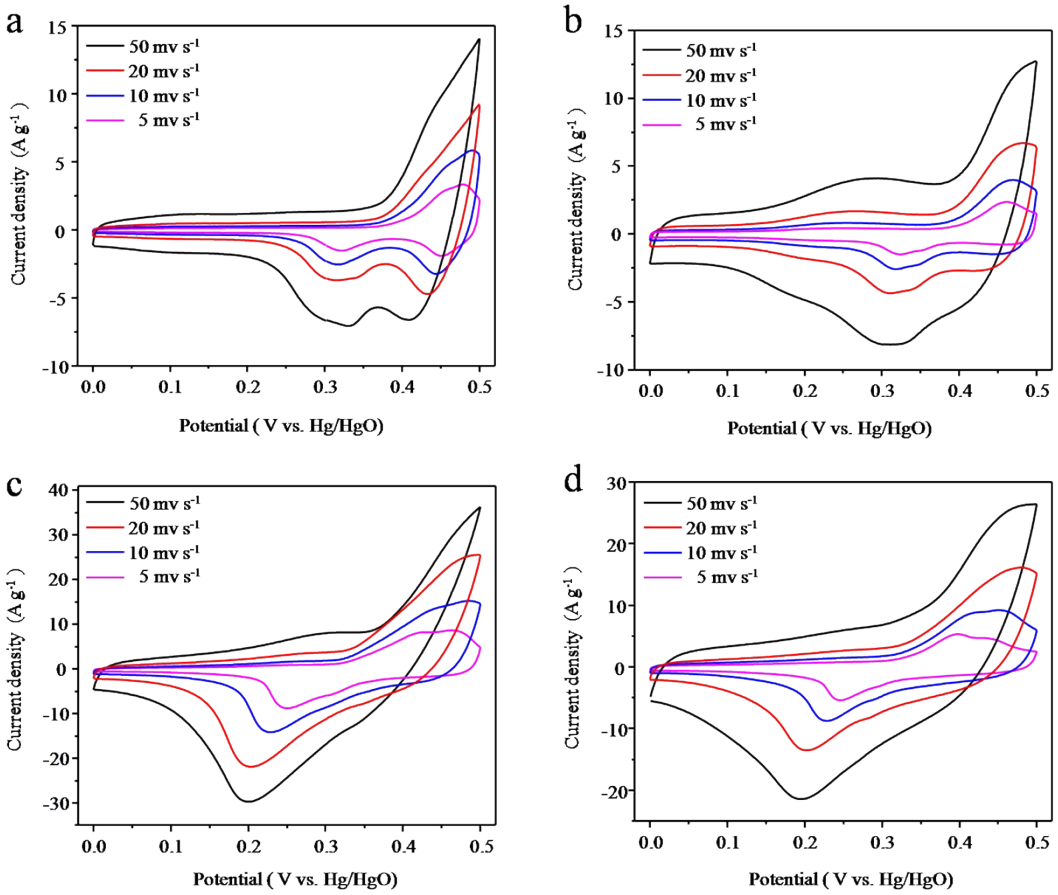

Figure S15. Cyclic voltammetry (CV) measurements of: (a) Co_3O_4, (b) NiO, (c) $Ni_xCo_{3-x}O_4$-2 and (d) $Ni_xCo_{3-x}O_4$-4 within 0.0–0.50 V at a scan rate from 5 to 50 mV s^{-1} in 6.0 M KOH electrolyte at room temperature.

15. Galvanostatic charge–discharge measurements

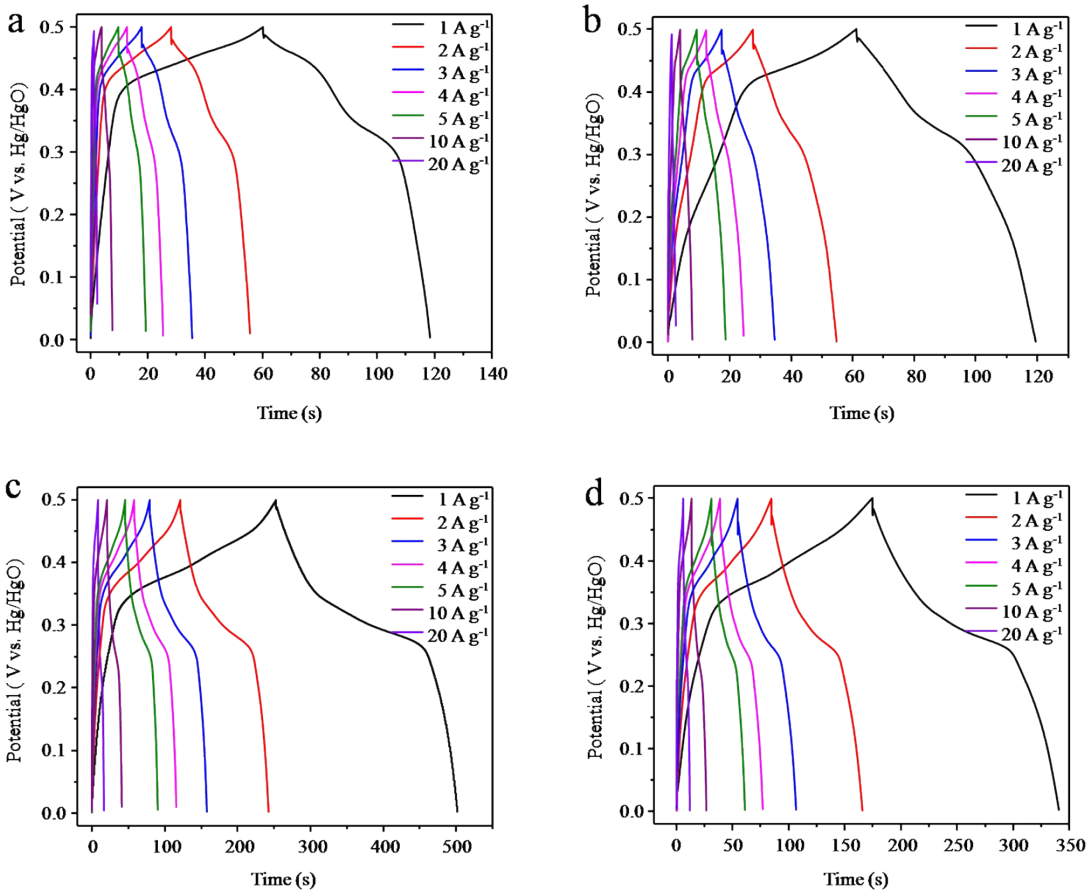

Figure S16. The galvanostatic charge–discharge curves of: (a) Co_3O_4, (b) NiO, (c) $Ni_xCo_{3-x}O_4$-2 and (d) $Ni_xCo_{3-x}O_4$-4 with current densities of 1, 2, 3, 4, 5, 10 and 20 A g^{-1} in 6.0 M KOH electrolyte at room temperature.

16. Comparison with some $NiCo_2O_4$ materials from literature.

Table S1. Comparison of electrochemical performance of as-prepared $Ni_xCo_{3-x}O_4$ nanoparticals with some $NiCo_2O_4$ materials from literature.

Material	Specific Capacitance (F g^{-1})	Rate performance	Capacitance retention	Reference
$Ni_xCo_{3-x}O_4$-1	797 (1 A g^{-1})	74.9% (20 A g^{-1})	80% (10000 cycles)	This work
$Ni_xCo_{3-x}O_4$-2	498 (1 A g^{-1})	67.1% (20A g^{-1})	72% (10000 cycles)	This work
$Ni_xCo_{3-x}O_4$-4	333 (1 A g^{-1})	67.3% (20A g^{-1})	75% (10000 cycles)	This work
$NiCo_2O_4$ nanowires	245 (1 A g^{-1})	78% (10 A g^{-1})	115% (1000 cycles)	1
$NiCo_2O_4$ nanosheets	123 (1 A g^{-1})	73% (10 A g^{-1})	95% (2200 cycles)	1
Porous $NiCo_2O_4$ nanowires	743 (1 A g^{-1})	78.6% (40A g^{-1})	93.8% (3000 cycles)	2
$NiCo_2O_4$ nanoflake@nanowire	891(1 A g^{-1})	69.5% (40 A g^{-1})	97.2% (8000 cycles)	3
Mesoporous $Ni_{0.3}Co_{2.7}O_4$ hierarchical structures	960 (0.625 A g^{-1})	83.9% (6.25 A g^{-1})	98.1% (3000 cycles)	4
$NiCo_2O_4$ nanoplates	294 (1 A g^{-1})	48% (10 A g^{-1})	89.8% (2200 cycles)	5
Hollow $NiCo_2O_4$ microsphere	678 (1 A g^{-1})	79.6% (10 A g^{-1})	87% (3500 cycles)	6
$NiCo_2O_4$ nanosheets on carbon nanofibers	1002 (1 A g^{-1})	67.3% (10 A g^{-1})	92.75% (2400 cycles)	7
$NiCo_2O_4$ nanowires	760 (1 A g^{-1})	70% (20 A g^{-1})	81% (3000 cycles)	8
NRGO-$NiCoO_2$	508 (0.5 A g^{-1})	No data	93% (2000 cycles)	9
$NiCo_2O_4$@graphene	778 (1 A g^{-1})	48% (80 A g^{-1})	90% (10000 cycles)	10
$NiCo_2O_4$ on carbon	660 (2 A g^{-1})	58.2% (16 A g^{-1})	91.8% (3000 cycles)	11

17. References

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